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## Emotion recognition and expression in individuals with Eating Disorders

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Emotion recognition and expression in individuals with Eating Disorders

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Doctor of Philosophy

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King's College London

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*“Eating, from birth on, is always closely intermingled  
with interpersonal and emotional experiences”*

Hilde Bruch

## ABSTRACT

---

This thesis explored emotion recognition and emotion expression in people with anorexia nervosa (AN) and bulimia nervosa (BN), compared to a matched healthy control group. It includes a set of distinct, but interrelated studies, which are described in two chapters, one for emotion recognition, and one for emotion expression. The broad hypothesis was that participants with eating disorders (ED) were less accurate recognising emotions and less facially expressive than HC.

Studies investigating emotion recognition:

Study 3.1 evaluated the ability to recognise emotions in blended facial expressions in adult women with AN (n=35), compared to HC (n=42). Participants with AN showed difficulties recognising disgust, and a preference to label non-angry facial expressions as anger.

Study 3.2 assessed emotion recognition through body movement in adolescents and adults with AN (n=97), compared to HC (n=96). Results indicated that participants with AN had difficulties recognising sadness, often misinterpreting it as a neutral emotion. Adolescent participants with AN had worse performance.

Study 3.3 investigated emotion recognition from facial expression and body movement in women with BN (n=26), compared to HC (n=42). Findings were similar to those of study 3.1, with BN participants having difficulties in disgust recognition, and showing a bias towards anger.

Studies investigating emotion expression:

Study 4.1 assessed facial expressions of positive emotions in people with AN (n=20), BN (n=20), and HC (n=20), through an examination of the Duchenne smile expressed in



response to a humorous film clip. The study results showed a reduced facial expression of positive emotions in people with AN.

Study 4.2 investigated facial expression of negative emotions in people with AN (n=20) and BN (n=20) compared to HC (n=20), by looking at expressions of sadness and other negative emotions in response to a sad film clip. There was no evidence of reduced facial expression in the ED group.

Study 4.3 explored the ability to deliberately generate (i.e. pose) and imitate facial expressions of emotions in a group of participants with AN (n=36), BN (n=25), and HC (n=42). Results revealed that both ED groups were less accurate than the HC group at posing facial expressions of emotions, and participants with AN had difficulties imitating facial expressions of emotions.

Overall, the findings provide evidence of difficulties in emotion processing in people with ED, especially reduced facial expression of emotion. The findings suggest that emotion recognition is more preserved, but there might be specific problems in the processing of disgust and anger. In general, participants with AN had more difficulties than those with BN.

The thesis findings provide support for emotional maintenance models of ED, and may inform the development of future treatments.

## ACKNOWLEDGEMENTS

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First, I would like to thank my supervisors, Dr Kate Tchanturia and Prof Robin Morris, for guiding me during this journey. Robin, thank you for your excellent advice, and attention to detail. Kate, I think I was extremely fortunate to have you as a supervisor, you have been incredibly supportive and have been able to challenge me to keep improving, whilst being completely understanding and flexible with my times and circumstances.

I am grateful of my current and former colleagues, Sam, Katie, Nick, Leon, and Heather, for welcoming me to this country and becoming my friends. Also to Sharon, Christiane and Sergio, not only for your hard work and contributions to this thesis, but also for your friendship.

I would like to thank all the participants who collaborated with this thesis. I hope the experience of participating was beneficial in some way, and that the findings of this thesis can translate into improvements in treatment.

Finally, I would like to thank my family. Fernando, thank you for your unconditional support during this journey, for your love and for always believing in me. Thanks to my mother-in-law for coming all the way from Chile to help us with Benjamin. Thanks to my mom and family for always being there for me. And thanks to my little Benjamin, because when I have felt too tired to continue, your smile has given me strengths to persevere. This thesis is for you, my son.

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## COMMON ABBREVIATIONS USED THROUGHOUT THIS THESIS

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AN	:	Anorexia nervosa
APA	:	American psychiatric association
AQ-10	:	Autism quotient
ASD	:	Autism spectrum disorder
AU	:	Action unit
BEAT	:	Beating eating disorders
BMI	:	Body mass index
BN	:	Bulimia nervosa
CFT-E	:	Compassion-focused therapy for eating disorders
CONICYT	:	Comisión Nacional de Investigación Científica y Tecnológica de Chile
CREST	:	Cognitive remediation and emotion skills training
DS	:	Duchenne smile
DSM-IV	:	Diagnostic and statistical manual of mental disorders, 4 <sup>th</sup> edition
DSM-5	:	Diagnostic and statistical manual of mental disorders, 5 <sup>th</sup> edition
EABT	:	Emotion acceptance behaviour therapy
ED	:	Eating disorder
EDE-Q	:	Eating disorder examination questionnaire
FACES	:	Facial expression coding system
FACS	:	Facial action coding system
FEEST	:	Facial expression of emotion: Stimuli and test
fMRI	:	Functional magnetic resonance imaging
HADS	:	Hospital anxiety and depression scale
HC	:	Healthy control

IBW	:	Ideal body weight
ICC	:	Intra-class correlation
IQR	:	Interquartile range
M	:	Mean
MANTRA	:	Maudsley model of anorexia nervosa treatment for adults
MBT-ED	:	Mentalisation based therapy for eating disorders
Mdn	:	Median
NDS	:	Non-Duchenne smile
NHS	:	National health service
NIHR	:	National institute for health research
OCI-R	:	Obsessive-compulsive inventory revised
PANAS	:	Positive and negative affect scale
PLW	:	Point-light walkers
RO-DBT	:	Radically open-dialectical behaviour therapy
SCID	:	Structured clinical interview for DSM-IV
SD	:	Standard deviation
SE	:	Standard error
SPAARS-ED	:	Schematic propositional analogical associative representation system model of ED
SPSS	:	Statistical package for the social sciences
SSRI	:	Selective serotonin re-uptake inhibitors
ToM	:	Theory of mind

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## INCORPORATION OF PUBLISHED ARTICLES

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The introduction of this thesis includes a review article that has been published in a peer-reviewed journal. In addition, studies 3.1, 3.2, 4.1 and 4.3 have been published as articles, thus, they have been incorporated into the thesis exactly as they appeared in the journals. The references, tables and figures that appear within the published articles are not incorporated into the reference lists of the main thesis.

## DISSEMINATIONS ASSOCIATED WITH THIS THESIS

### Peer-Reviewed Articles

Tchanturia, K, **Dapelo, MM**, Harrison, A, Hambrook, D (2015) Why study positive emotions in the context of eating disorders? *Current Psychiatry Reports*, 17(1): 537.

This article is included in Chapter 1.

**Dapelo, MM**, Surguladze, S, Morris, R, Tchanturia, K (2015) Emotion recognition in blended facial expressions in women with anorexia nervosa. *European Eating Disorders Review*. DOI: 10.1002/erv.2403.

This article is included in Chapter 3.

Lang, K, **Dapelo, MM**, Khondoker, M, Morris, R, Surguladze, S, Treasure, J, Tchanturia, K (2015) Exploring emotion recognition in adults and adolescent with anorexia nervosa using a body motion paradigm. *European Eating Disorders Review*, 23(4): 262-268.

This article is included in Chapter 3.

**Dapelo, MM**, Hart, S, Hale, C, Morris, R, Lynch TR, Tchanturia, K (2015) Facial expression of positive emotions in individuals with eating disorders. *Psychiatry Research*, 230(1):70-77.

This article is included in Chapter 4.

**Dapelo, MM**, Bodas, S, Morris, R, Tchanturia, K (2016) Deliberately generated and imitated facial expressions of emotions in people with eating disorders. *J Affect Disorders*, 191:1-7. DOI: 10.1016/j.jad.2015.10.044.

This article is included in Chapter 4.

### **Other disseminations**

Tchanturia, K, **Dapelo, MM**, Morris, R. Facial expression of positive emotions in individuals with eating disorders. Oral presentation. XXI<sup>st</sup> Annual meeting of the Eating Disorders Research Society (EDRS), Taormina, September 2015.

**Dapelo, MM**. Difficulties in emotion functioning in patients with eating disorders. Research teaser presented at the Annual General Meeting of the Network of Chilean Students and Researchers in the UK (REUK), London, May 2015.

**Dapelo, MM**. Emotion processing in women with eating disorders. Oral presentation. Psychological Medicine Department meeting. Institute of Psychiatry, Psychology and Neuroscience, London, May 2015.

**Dapelo, MM**, Hart, S, Hale, C, Morris, R, Lynch TR, Tchanturia, K Positive facial expression in people with eating disorders: An in-depth look at the smile. Poster presented at the PhD/MD(Res) Research Showcase. Institute of Psychiatry, Psychology and Neuroscience, London, March 2015.

**Dapelo, MM**, Hart, S. Facial expression in eating disorders: AN in-depth look at the smile. Oral presentation. Eating Disorders section research meeting. Institute of Psychiatry, Psychology and Neuroscience, London, December 2014.

**Dapelo, MM**, Lang, K, Khondoker, M, Morris, R, Surguladze, S, Treasure, J, Tchanturia, K. Recognising emotions in body movements: A study in individuals with anorexia nervosa and healthy controls. Poster presented at the Palliative and Psychological Medicine PhD Symposium, London, November 2014.

**Dapelo, MM**. Emotion recognition in anorexia nervosa: The use of point-light walkers. Oral presentation. Eating Disorders section research meeting. Institute of Psychiatry, Psychology and Neuroscience, London, May 2014.



## **DECLARATION OF THE CANDIDATE’S ROLE IN EACH OF THE STUDIES**

---

### **Chapter 1:**

The candidate conducted a literature review and wrote the introduction independently.

The review article included in Chapter 1 has joint first authorship between the candidate and the first supervisor, Dr Kate Tchanturia. Literature searches were conducted by the candidate and checked by Dr Tchanturia. Interpretations were made by the candidate in conjunction with Dr Tchanturia and the other co-authors.

### **Chapter 3-4:**

The candidate recruited and tested the participants for the studies included in these chapters and conducted the data analysis. The interpretation of the results is the work of the candidate with input from the first and second supervisor (Dr Kate Tchanturia and Prof Robin Morris) and other co-authors.

Study 3.1 was conducted jointly with Ms Katie Lang (PhD student, first supervisor: Dr Kate Tchanturia), who contributed with half of the dataset and provided significant input in the interpretation of the results. The candidate has joint first authorship in the study article with Ms Lang. In addition, statistical advice for this study was provided by Dr Mizanur Khondoker.

The article for study 4.1 was written jointly with Ms Sharon Hart (Masters student, supervisor: Dr Kate Tchanturia), who shares first authorship with the candidate. Ms Hart coded the facial expression of a large proportion of participants, and contributed to the data interpretation. Facial expressions were also coded by Ms Christiane Hale.

In addition, Ms Hart and Ms Hale coded the facial expressions of participants of study 4.2. Mr Sergio Bodas rated facial expressions for study 4.3.

The above studies were supervised by Dr Kate Tchanturia and Prof Robin Morris.

## CHAPTER 1

---

### INTRODUCTION

## **OVERVIEW**

This chapter reviews the theoretical and empirical literature that informed the development of this project.

This thesis aims to better understand the way people with anorexia nervosa (AN) and bulimia nervosa (BN) recognise and express emotions. Because of a focus on emotional processes, the project has been largely informed by the literature on this topic, with this chapter beginning with a section reviewing the literature concerning basic emotions, their function, recognition and expression. The intention is not to review the topic completely, but cover the literature that is directly relevant to the research conducted.

The second section of the chapter focuses on eating disorders (ED), reviewing emotional maintenance models of ED and therapeutic interventions that address emotional difficulties in ED. At the end of this section, a peer-reviewed published article is included, reviewing the empirical literature on emotion recognition and expression in ED, with an emphasis on positive emotions.

Finally, the aims of this thesis are presented, along with a ‘map’ of the studies included in the thesis.

# INTRODUCTION

## 1. 1. EMOTIONS

Emotions have been the focus of study of a wide range of disciplines, such as philosophy, anthropology, sociology, and psychology. Within these frameworks, many theories have attempted to explain the nature, characteristics and typology of emotions.

### 1.1.1. Basic emotions

A number of researchers have argued that there are primary or basic emotions, which are shared by all humans, are inherited, and have evolutionary purpose (e.g., Tomkins, 1962, Izard, 1971, Ekman, 1987, and Panksepp, 1992). A brief description of some of the most relevant theories within this framework will be offered first, and then the basic emotion theory proposed by the American psychologist Paul Ekman (1992) will be described in more detail, since this theory provides a main theoretical framework for this thesis.

#### *1.1.1.1. Affect theory (Tomkins, 1962)*

Silvan Tomkins's affect theory (Tomkins, 1962) proposed that affective responses are the primary motives of human beings. Tomkins argued that affects are primarily facial behaviours that are controlled by an innate inherited program, and identified eight primary affects (i.e., interest-excitement, enjoyment-joy, surprise-startle, distress-anguish, fear-terror, shame-humiliation, contempt-disgust, anger-rage) (Tomkins & McCarter, 1964). According to this view, when someone becomes aware of their facial expression, then becomes aware of their affects (Tomkins & McCarter, 1964). This emphasis on facial expressions lead to an increased number of studies in the following years, investigating facial expression of

emotions and emotion recognition in faces, conducted by Tomkins and also by Carroll Izard and Paul Ekman.

#### *1.1.1.2. Differential emotions theory (Izard, 1971)*

Carroll Izard proposed the differential emotions theory (Izard, 1971), in which emotions are seen as feeling states or motivational conditions that are an immediate product of particular neural processes (Izard, 1992). Izard agreed with Tomkins in the existence of basic emotions, which have innate neural substrates, a unique and universally recognised facial expression, and a unique feeling state (Izard, 1992). However, contrary to Tomkin's affect theory, in the differential emotions theory observable expressions are not viewed as a necessary component of emotions (Izard, 1977). The theory highlights the adaptive function of emotions and hypothesises that they play a central role in helping the individual achieve the major developmental milestones at each stage of life (Abe & Izard, 1999). More recent developments of the differential emotions theory propose that basic emotions can be seen as "natural kinds" (i.e., phenomena that are given by nature, with similar universal observable properties). According to the differential emotions theory, the following basic emotions meet criteria for classification as natural kinds: interest, joy/happiness, sadness, anger, disgust, and fear (Izard, 2007).

#### *1.1.1.3. Evolutionary model of basic emotions (Panksepp, 1992)*

From the perspective of affective neuroscience, Jaak Panksepp (1992) also coincides with Izard and Tompkins in the existence of basic emotions. According to his evolutionary model of basic emotions, the key to better understand emotions is to unravel the brain mechanisms that underpin the emotional response in human and non-human mammals (Panksepp, 1992). The model proposes that there is a limited number of neural systems in the brain that

trigger and orchestrate the emotional response (physiological, behavioural, and psychological), and these neural systems have been developed by evolutionary selection, rather than by the experiences gained by an organism during a single life span. These neural systems generate a variety of responses, such as offensive attack, flight, separation calls, rough-and-tumble play, and foraging-exploratory activities, which are accompanied by distinct affective feelings in humans, and probably also in other animals (Panksepp, 1992). Panskepp (2006) describes seven basic emotional systems: lust, care, panic, play, fear, rage and seeking.

### **1.1.2. Basic emotion theory (Ekman, 1987)**

The basic emotion theory defines emotions as “discrete, automatic responses to universally shared, culture-specific and individual-specific events” (Ekman & Cordaro, 2011, p. 364). It is proposed that there are six basic emotions (i.e., anger, disgust, fear, happiness, surprise, and sadness) that are discrete and distinguishable from each other. Each of these basic emotions is seen as an ‘emotion family’ that groups emotional states that are related to each other, but different from other ‘emotion families’ (Ekman & Cordaro, 2011). For example, the basic emotion ‘fear’ can be seen as an ‘emotion family’ that can range from a slight apprehension to terror, but it is fundamentally distinct from other basic emotions, such as ‘anger’ (Ekman & Friesen, 2003).

An evolutionary viewpoint is adopted in which the basic emotion theory sees emotions as automatic responses to the environment and assumes that emotions have enabled humans to respond adaptively to threats and opportunities in the course of evolution (Ekman, 1992; Ekman & Cordaro, 2011; Izard, 2007; Matsumoto, Keltner, Shiota, O'Sullivan, & Frank, 2008). For example, disgust is an aversion response that is triggered by tasting or smelling something repulsive, such as rotten food. The disgust response aims at removing oneself

from the repulsive object, and in its most extreme form, can include vomiting the repulsive object (Ekman & Friesen, 2003). This response pattern therefore has evolutionary value, preventing humans from ingesting poisonous food. In developing these notions, Ekman built upon the work of Charles Darwin (1872/2003), who proposed that the main expressions of emotions are innate and inherited, and that expressions that once served a functional purpose have remained over time through habit (Darwin, 1872/2003). For example, the disgust expression reflects the vomit response in that the mouth is open with the upper lip strongly retracted, which wrinkles the sides of the nose; over time these movements became associated with the experience of disgust and are now depicted in a wide variety of situations in which an individual encounters something repulsive, without necessarily provoking vomit (Darwin, 1872/2003).

This emphasis on inherited aspects of the emotion response does not preclude from acknowledging the impact of learning and culture. Early on, Ekman (1987) proposed that even though basic emotions are universal, culture influences emotion expression through ‘display rules’, which can mask, intensify, de-intensify, or neutralise expressions, according to what is appropriate for the particular social and cultural context (Ekman et al., 1987). More recent views within basic emotion theory suggest that the impact of cultural and social learning on emotions goes beyond display rules, influencing attitudes towards emotions, cognitive representations of emotional experiences, coping mechanisms, and emotion triggers (Ekman & Cordaro, 2011). Thus, the inherited response pattern associated with each emotion can vary depending on what a specific individual has learned and experienced during his or her life. This is particularly evident in the case of psychopathology, where some aspects of the emotional response can differ significantly from the response of people of the same culture. For example, people with schizophrenia usually show flat affect, exhibiting a

reduced emotional response, and limited facial expression of emotions (for a review, see Kring & Moran, 2008).

According to the basic emotion theory, emotions have a distinctive universal physiology (e.g., Rainville, Bechara, Naqvi, & Damasio, 2006; Stephens, Christie, & Friedman, 2010), experience (Ekman, 1992), and expression (Ekman & Cordaro, 2011; Kohler et al., 2004), with characteristics as seen in table 1.1.



**Table 1.1. Characteristics of basic emotions**

Distinctive universal signals or expressions
Distinctive physiology
Automatic appraisal
Distinctive universal antecedent events
Presence in other primates
Quick onset
Brief duration
Unbidden occurrence
Distinctive thoughts, memories, and images
Distinctive subjective experience
Refractory period in which information is filtered to what supports the emotion
Unconstrained target
Can be enacted in either constructive or destructive fashion

Source: Ekman and Cordaro (2011)

Within this, there is a robust body of evidence showing that anger, disgust, fear, sadness, surprise and happiness constitute basic emotions. In addition, there is partial evidence for other emotional states, such as contempt, relief, wonder, guilt, shame, and envy, amongst others (for a review, see Ekman & Cordaro, 2011). This thesis focuses on the processing of 5 basic emotions (anger, disgust, fear, sadness, and happiness), and thus, these emotions are discussed in a more detailed fashion.

#### *1.1.2.1. Basic emotions*

##### *1.1.2.1.1. Anger*

Anger can be triggered in different ways. The most common situation is when something or someone interferes with the pursuit of an individual's goals (Ekman & Cordaro, 2011; Lemerise & Dodge, 2008). Within this, people may feel anger towards other people, but also towards objects, and natural events (Ekman & Friesen, 2003). Another trigger for anger is physical or psychological threat, which can prompt a response to fight back (Ekman & Cordaro, 2011).

The main function of the anger response is to remove the obstacle by a physical or verbal attack. In the anger response the blood flow to the arms and hands increases, preparing the body for a fight (Levenson, Ekman, & Friesen, 1990).

Anger varies in intensity, from slight irritation or annoyance to rage or fury. It can have a sudden onset or build up gradually, starting with irritation and slowly accumulating. The risk of losing control is part of the experience of intense anger. Some people, who have difficulties expressing anger, may turn it inward upon themselves (Ekman & Friesen, 2003).

#### 1.1.2.1.2. Disgust

Disgust is a feeling of aversion usually triggered by the sight, smell, or taste of something repulsive (Ekman & Cordaro, 2011), but it can also be elicited by the actions or appearances of people that are considered revolting or repulsive, or even ideas that are offensive, such as religious beliefs (Ritter & Preston, 2011).

Disgust can vary in intensity from mild dislike to extreme disgust. In such extreme, the disgust response usually involves removing the repulsive object or oneself from the object (Ekman & Friesen, 2003). The physiological changes involved in disgust can trigger the gag reflex and restrict the airflow to the olfactory system (Koerner & Antony, 2010), and nausea and vomiting can occur (Ekman & Cordaro, 2011).

#### 1.1.2.1.3. Fear

Fear is triggered in response to the threat of harm, which can be physical or psychological, or both (Ekman & Cordaro, 2011). Physical harm can vary from something minor to a life-threatening experience. Harm can be real or imagined. People can fear any event, person, animal, thing or idea that appears dangerous (Ekman & Friesen, 2003).

The thalamus and the amygdala have been shown to be involved in the processing of fear (LeDoux & Phelps, 2008). The fear response can include dilation of pupils, sweating, piloerection and pale coloration in the face (Matsumoto et al., 2008).

Even though the intensity of fear can vary from apprehension to terror, being afraid is always an unpleasant experience (an exception might be slight fear experienced in extreme sports like base-jumping, or when riding a rollercoaster, but in these cases the person usually assumes that there is no real threat of harm) (Ekman & Friesen, 2003).

Learning to avoid or escape from situations that cause severe pain and the likelihood of physical injury is key for survival, thus the fear response activates impulses to flee, with

blood flowing to the arms and legs (Ohman, 2008). This way, the fear of danger mobilises efforts to avoid harm (Tomkins, 1963). However, it must be noted that fear can also activate a response to freeze, and that sometimes the fear experienced in anticipation to pain can be more miserable than the pain itself (Ekman & Friesen, 2003).

#### 1.1.2.1.4. Sadness

The most common trigger of sadness is the experience of loss because of the death, or rejection of a loved one (Ekman & Cordaro, 2011). Sadness is a variation of distress, but whilst distress usually involves an active response, such as crying, the sadness response is passive and quite. The reason for this may be that in the case of loss, nothing can be done to change the source of the suffering. The experience of sadness often involves feelings of hopelessness, disappointment, or resignation. Unlike other emotions, sadness can last long periods of time (Ekman & Friesen, 2003).

The intensity of sadness varies from slight feelings of being 'blue' to the extreme felt when mourning. In the most extreme form, there may be loss of facial muscle tone with the person remaining motionless (Ekman & Friesen, 2003). Thus, the function of the sad response is to turn the attention inward, promoting personal reflection and resignation and acceptance of the loss (Lazarus, 1991).

#### 1.1.2.1.5. Happiness

A wide range of experiences can trigger happiness. Pleasurable and exciting experiences and their anticipation can provoke happiness. It can also be experienced when pain stops. Sometimes happiness is associated to people's self-concept and self-esteem. Situations of social approval and praise can provoke happiness, as well as rewarding relationships like friendships, and feeling loved by others (Ekman & Friesen, 2003).

Often events that trigger happiness do so through more than one path. For example, the enjoyment someone experiences whilst engaging in a sport activity can come from the excitement of the competition and from playing well, which reinforces a favourable self-concept.

Happiness, in functioning as a reward for behaviour (Ekman & Friesen, 2003) is associated with a physiological response in which significant quantities of oxytocin are released, which have been linked to a motivation to commit and care for others (Keltner, Kogan, Piff, & Saturn, 2014; Turner, Altemus, Enos, Cooper, & McGuinness, 1999; Uvnas-Moberg, 1998). As with all other emotions described, the intensity of happiness can vary, from mild happiness to ecstasy. The emotional response can go from a smile to, in the most extreme, laughing with tears (Ekman & Friesen, 2003).

#### *1.1.2.2. Positive, negative emotions and blended emotions*

The basic emotions described above are usually referred to as ‘negative emotions’ (for anger, disgust, fear and sadness), and ‘positive emotions’ (for happiness). However, according to the basic emotion theory none of them is inherently negative or positive. Instead, the theory poses that all emotions can be enacted in a constructive or destructive manner (Graham, Huang, Clark, & Helgeson, 2008).

Emotions rarely occur in pure form. The same situation can trigger more than one emotion at the same time. For example, physical threats can trigger fear and anger. Sometimes the way a situation is appraised or interpreted changes over time and people experience a stream of emotional responses, one after the other. In other occasions emotions overlap, blending (Ekman & Cordaro, 2011). Blended emotions can be similar in strength, or one emotion can be more salient than the other (Ekman et al., 1987). In addition, people can have an

emotional reaction to the emotion initially felt. For example, a person can feel angry for feeling so sad after being abandoned by a partner (Tomkins & McCarter, 1964).

#### *1.1.2.3. Facial emotion recognition*

Darwin suggested that emotion expression is likely to be instinctive in humans, and conversely, so it is detection (Darwin, 1872/2003). According to this evolutionist view, detection includes being able to recognise reliable signs of discrete emotions. Given that facial expressions are viewed as universal, they can be recognised as discrete categories (Matsumoto et al., 2008).

Studies on facial emotion recognition in different cultures carried out by Ekman (1969, 1987) and Izard (1971) provide empirical support for the universality of emotion recognition (Ekman et al., 1987; Ekman, Sorenson, & Friesen, 1969; Izard, 1971). For example, when showing pictures of facial expressions of anger, disgust, fear, happiness, sadness and surprise to university students from 10 different nations (i.e., Estonia, Germany, Greece, Hong Kong, Italy, Japan, Scotland, Sumatra, Turkey, and United States) it was found that despite the different cultural contexts, participants were able to correctly recognise the emotions (Ekman et al., 1987). More recent studies in the area have generally confirmed that people are able to recognise discrete facial expressions of emotions (Kohler et al., 2004), even though evidence against exists (Russell, 1994).

The claim that basic emotions are universally recognised does not imply that all basic emotions are identified equally well. In fact, it has been suggested that there are gradients of emotion recognition, with some emotions being more easily recognised than others (Haidt & Keltner, 1999). For example, based on the results obtained in the study previously described (Ekman et al., 1987), it can be inferred that facial expressions of happiness might be the easiest to recognise (in Ekman's study it was correctly identified by 90.4% of participants),

followed by facial expressions of surprise (correctly identified by 89.7% of participants), sadness (85.3%), fear (79.8%), anger (74.1%), and disgust (73.2%).

Several brain structures participate in the process of recognising emotions, such as the occipitotemporal cortex, orbitofrontal cortex, right parietal cortex, amygdala, insula and basal ganglia (Adolphs, 2002). Of all, the amygdala seems to be particularly relevant in the recognition of facial expressions of negative emotions, especially fear. Also, the insula and basal ganglia have shown to be implicated in the recognition of disgust (Adolphs, 2002; Adolphs, Tranel, Damasio, & Damasio, 1994; Phillips et al., 1997).

Most of the research on emotion recognition has focused on the identification of single, prototypical facial expressions. However, as previously mentioned, facial expressions can display more than one emotion (Ekman & Cordaro, 2011). Even though research on recognition of blended expressions of emotions is less abundant than the literature of prototypical expressions, it has been shown that blended facial expressions of emotions can be recognised as discrete emotions, in a similar fashion of single, prototypical facial expressions (specially when there is one predominant emotion in the blend) (Young, Perret, Calder, Sprengelmeyer, & Ekman, 2002; Young et al., 1997).


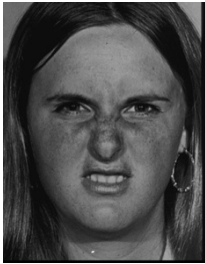
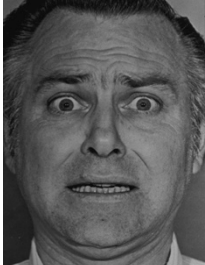

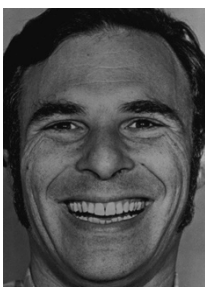
#### *1.1.2.4. Facial emotion expression*

Prototypical facial expressions for the basic emotions considered in this thesis are shown in table 1.2. Even though these are the most typical facial expressions for each emotion, it needs to be noted that people often exhibit some signs, but not all of them (Ekman, Friesen, & Hager, 2002). For example, someone can raise the upper lip when feeling disgust, without showing major movements in nose and brows. Also, the images shown in table 1.2 are depicting expressions of emotions at a high intensity, but expressions can be less intense (Ekman & Friesen, 2003). Finally, as stated before, real-life experiences can produce blended

emotions, and thus the face can simultaneously show signs of more than one emotion (Ekman & Cordaro, 2011).



**Table 1.2. Prototypical facial expressions of basic emotions**

Emotion	Prototypical facial expression
Anger	<ul style="list-style-type: none"> <li>• Brows are lowered and drawn together.</li> <li>• Vertical lines appear between the brows.</li> <li>• Lower lid is tensed and may or may not be raised.</li> <li>• Upper lid is tense and may or may not be lowered by the action of the brow.</li> <li>• Eyes have a hard stare and may have bulging appearance.</li> <li>• Lips are in either of two basic positions: pressed firmly together, with the corners straight or down; or open, tensed as if shouting.</li> </ul> 
Disgust	<ul style="list-style-type: none"> <li>• Brow is lowered, lowering the upper lid.</li> <li>• Lines show below the lower lid, which is pushed up.</li> <li>• Cheeks are raised</li> <li>• Nose is wrinkled.</li> <li>• Upper lip is raised.</li> <li>• Lower lip is also raised and pushed up to the upper lip, or is lowered and slightly protruding.</li> </ul> 
Fear	<ul style="list-style-type: none"> <li>• Brows are raised and drawn together.</li> <li>• Presence of wrinkles in the centre of the forehead.</li> <li>• Upper eyelid is raised, and the lower eyelid is tensed and drawn up.</li> <li>• Mouth is open and the lips are either tensed slightly or drawn back or stretched and drawn back.</li> </ul> 
Sadness	<ul style="list-style-type: none"> <li>• Inner corners of the eyebrow are drawn up.</li> <li>• Skin below the eyebrow is triangulated, with the inner corner up.</li> <li>• Upper eyelid inner corner is raised.</li> <li>• Corners of the lips are down or the lips are trembling.</li> </ul> 
Happiness	<ul style="list-style-type: none"> <li>• The lower eyelid shows wrinkles below it, and may be raised but not tense.</li> <li>• Crow's feet wrinkles go outward from the outer corner of the eyes.</li> <li>• Cheeks are raised.</li> <li>• A wrinkle runs down from the nose to the outer edge beyond the lip corners.</li> <li>• Corners of the lips are drawn back and up.</li> <li>• Mouth may or may not be parted, with teeth exposed or not.</li> </ul> 

Source: Information: Ekman and Friesen (2003); pictures: Pictures of facial affect set (Ekman & Friesen, 1976)

#### 1.1.2.4.1. The Duchenne smile.

As seen in table 1.2 the smile is part of the facial expression for happiness. Smiles are powerful signs of social reward (LaFrance, 2011), and people associate them with happiness and positive intentions (Floyd & Burgoon, 1999). However, as Darwin (1872/1990) noted, not all smiles are signals of genuine happiness or joy.

The smile of happiness can be distinguished by the activation of the muscle that contracts the outer corner of the eyebrows (i.e., orbicularis oculi), producing ‘crow’s feet’ wrinkles (Darwin, 1872/2003; Ekman & Friesen, 1982). The action of this muscle was first described by Duchenne (1862/1990), so this type of smiles are called ‘Duchenne smiles’ (Ekman, Davidson, & Friesen, 1990; Ekman & Friesen, 1982). Duchenne smiles have shown to evoke positive emotions in others, promoting social interaction and wellbeing (Harker & Keltner, 2001; Keltner & Bonanno, 1997). However, it needs to be acknowledge that there is also evidence that Duchenne smiles are possible to fake (Krumhuber & Manstead, 2009).

People also smile when they do not feel happy. When a smile is shown to conceal a negative emotion is usually called ‘masking smile’ (Ekman et al., 1990). People smile in unpleasant situations, to show that they are willing to endure the circumstances. This kind of smile is sometimes referred to as ‘miserable smile’ (Ekman et al., 1990). People can simulate a smile, to convince the other person that they are feeling happy, when they really are not. This is known as a ‘false smile’ (Ekman et al., 1990). People smile to make a tense situation more comfortable, as a sign of submissive behaviour, in response to someone else’s smile, and in many other circumstances (Ekman & Friesen, 2003). All the smiles described above do not activate the ‘orbicularis oculi’ and are usually referred to as ‘Non-Duchenne smiles’ (Ekman & Friesen, 2003).

### **1.1.3. Other theoretical frameworks**

Ekman's basic emotion theory has not been exempt from criticism. Early on, investigators questioned the universality of basic emotions (Russell, 1994). More recently, some researchers have challenged the notion of discrete emotions, proposing broad affective dimensions instead (Russell, 2003). In addition, it has been argued that emotions are not biologically determined nor recognised, but constructed by the mind (Barrett, 2006). (For a review on critical views on the basic emotion theory, see Scarantino & Griffiths, 2011).

Some critical appraisals of the basic emotion theory can be seen as a complement of Ekman's theory and have informed the development of the thesis. These theoretical frameworks are briefly reviewed.

#### *1.1.3.1. Emotion recognition in body movements*

The emotional response comprises multimodal, dynamic patterns of behaviour that can involve facial expressions, vocalizations, body movements, gaze, gestures, head movements, touch, autonomic response, and even scent (Keltner & Lerner, 2010; Matsumoto et al., 2008). However, most of the research on emotion recognition has been focused on the ability to recognise emotions in people's faces and less is known about emotion recognition from body movements.

Despite the fact that Darwin (1872/2003) included information about body movements and postures in his description of emotion expressions in humans, both Tomkins and Ekman argued that emotions are primarily shown in the face, and body movements only play a secondary role, providing information about the intensity of the emotion (Ekman & Friesen, 1974). However, more recent views claim that the quality of the emotion is also expressed through body movements (Keltner & Lerner, 2010).

It has been shown that the posture and movements of the head, arms, hands, legs, and feet can reveal information about the inner emotional experience (Wallbott, 1998), and also about the action that is triggered by the emotion (De Gelder, 2006; Demeijer, 1989). For example, a person approaching someone with a menacing posture and clenched fists is likely to be angry and ready to attack (Bolton, 1979).

Although the evidence is less robust than for facial expressions, it indicates that certain patterns of body movements may be specific to certain emotions. For example, a collapsed posture and general lack of movement seem to be typical of sadness; whereas anger seems to be characterised by an erected posture along with expansive movements in arms and hands, such as opening and closing hands (Wallbott, 1998). Even though the universality of such expressions of emotions has not been established yet, there is evidence that people are able to infer emotional states by observing particular body movements (Atkinson, Dittrich, Gemmell, & Young, 2004; Demeijer, 1989; Heberlein, Adolphs, Tranel, & Damasio, 2004)

#### *1.1.3.2. Function of facial expressions.*

The basic emotion theory assumes that the main function of facial expressions is to convey emotional states (Darwin, 1872/2003; Ekman & Friesen, 2003). However, other theorists have proposed alternative functions.

Fridlund (1994) in his behavioural ecology view of facial expressions argues that facial expressions indicate behavioural intentions or action requests. According to this view, facial expressions are not seen as means to convey information about emotions, but rather tools for communicating information to others (Fridlund, 1994).

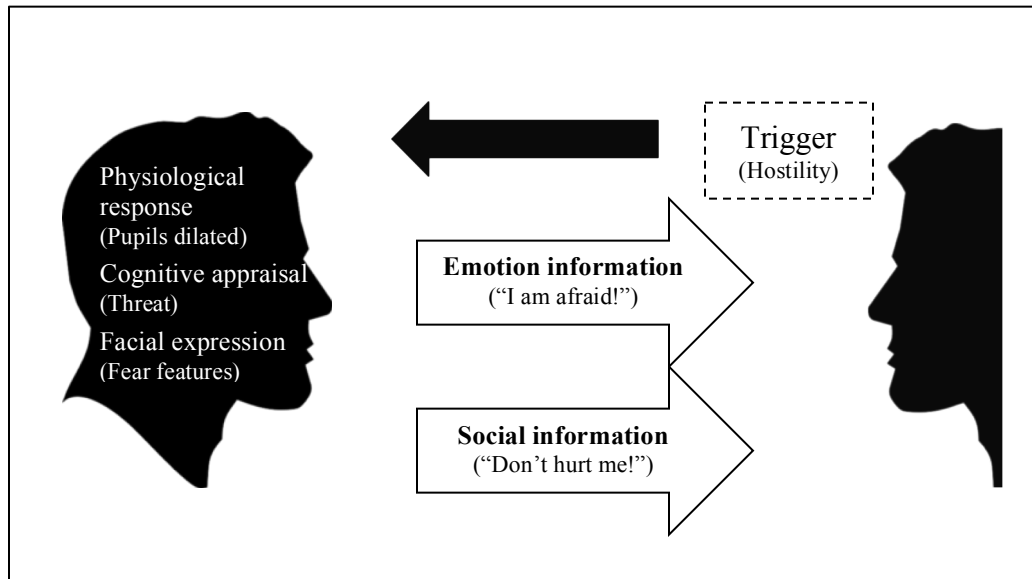
Just like the basic emotions theory, the behavioural ecology theory assumes that facial expressions have evolutionary value, but it argues that this value is not given by reflecting an internal state, such as emotions; instead, is given by communicating motives, intentions, and

actions to others. For example, in a dispute a person (A) may display a facial expression that conveys the message “Back off or I’ll attack!” to deter the opponent (B). If the B retracts in response to the expression, A would have achieved his goal without having to fight, preventing the risk of injury or even death, which has an evolutionary value (Horstmann, 2003).

Even though Fridlund (1994) has criticised Ekman’s theory of facial expressions as emotional readouts and formulated his theory as an alternative view, it has been proposed that both theories could complement each other. According to this, facial expressions can communicate both emotions and intentions (Dethier, Blairy, Rosenberg, & McDonald, 2012). For example, in the dispute described in the previous paragraph, the aggressive facial expression of A can trigger in B an emotional response with a physiological reaction (e.g. dilation of the pupils, sweating), cognitive appraisal (e.g., he is threatening me, this is dangerous), and a facial expression showing the features of fear, indicating that (a) B is afraid, and (b) B does not want to be hurt and is ready for submission (Figure 1.1).





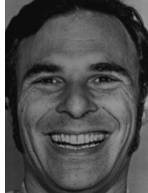
Table 1.3 shows a summary of the characteristics of each emotion studied in this thesis, merging contents from the basic emotion theory (Ekman, 1992) and behavioural ecology (Fridlund, 1994) including common triggers, emotion function, prototypical facial expression, and social function of the facial expression.

**Figure 1.1. Emotional response, combining aspects of the basic emotion theory (Ekman, 1992) and the behavioural ecology theory (Fridlund, 1994)**



A trigger activates an emotional response, including a physiological reaction, cognitive appraisal, and facial expression. The facial expression conveys two messages, one regarding the internal emotional state (Emotion information), and other regarding intentions or social motives (Social information).

**Table 1.3. Summary of main characteristics of the emotions considered in this thesis**

Emotion	Common triggers	Function	Prototypical facial expression	Social function of facial expression
Anger	<ul style="list-style-type: none"> <li>• Interference with goals</li> <li>• Physical/psychological threats</li> <li>• Actions against moral values</li> </ul>	To attack or warn of an attack		To deter the opponent or to attack
Disgust	<ul style="list-style-type: none"> <li>• Sight, smell, or taste of something repulsive</li> <li>• Revolting actions/ offensive ideas</li> </ul>	To remove the repulsive object		Reaction to bad smelling or bad tasting
Fear	<ul style="list-style-type: none"> <li>• Physical/psychological threats</li> </ul>	To avoid or escape from harm		To submit or escape Desire to be rescued
Sadness	<ul style="list-style-type: none"> <li>• Loss of a loved one</li> <li>• Any loss</li> </ul>	To promote acceptance of loss		To ask for help
Happiness	<ul style="list-style-type: none"> <li>• Pleasurable experiences</li> <li>• Exciting experiences</li> <li>• Relief</li> <li>• Experiences that enhance self-concept</li> </ul>	To reward		To affiliate

#### *1.1.3.3. Spontaneous and posed facial expressions of emotion.*

Facial expressions of emotion can be spontaneous or produced voluntarily. Ekman (1990) claims that only spontaneous, involuntary facial expressions are real signs of emotions. An example of this is the Duchenne smile, which is associated with happiness and is usually shown spontaneously; whereas Non-Duchenne smiles, which are not linked to positive emotions, are usually produced more voluntarily (Ekman et al., 1990; Ekman & Friesen, 1982).

However, the study of voluntary, posed facial expressions of emotions is still relevant for understanding facial expression, especially if both the emotional function (i.e. basic emotion theory), and the social function (i.e. behavioural ecology theory) of facial expressions of emotion are considered.

It has been proposed that even though the study of spontaneous facial expressions can provide information about the extent to which people are able to convey emotions (emotional function), spontaneous expressions may not reflect a deliberate attempt to deliver a message to others (social function) (Dethier et al., 2012). This is because spontaneous facial expressions are unintentional, and the behavioural ecology view understands facial expressions as means to communicate intentions (Dethier et al., 2012). Instead, posed facial expressions, which are more regulated by cognitive control (Rinn, 1984), may reflect skills required when using facial expressions to communicate intentions to others (Dethier et al., 2012).

Thus, the study of spontaneous expression of emotions seems to be better fit for the study of facial expressions as readout of emotions (emotional function), and the study of posed expressions of emotions might be better suited for the study of facial expressions as communication tools (social function).



#### *1.1.3.4. Imitation of facial expressions of emotions.*

The basic emotion theory assumes that emotional responses, such as facial expressions, are inherited and automatic responses (Ekman, 1992). However, that does not preclude learning from playing a relevant role in the development of facial expressions of emotions. In fact, recent developments of the basic emotion theory emphasise the role of learning in display rules, attitudes towards emotions, cognitive representations of emotional experiences, coping mechanisms, and emotion triggers (Ekman & Cordaro, 2011).

In general, imitation can be understood as a process in which people reproduce both the form and the intention of a modelled action (Tomasello, Kruger, & Ratner, 1993). People start imitating facial expressions early in life, as young as 12-27 days old (Meltzoff & Moore, 1977), and it has been proposed that imitation is a key mechanism in learning to control one's facial expression (Williams, Nicolson, Clephan, De Grauw, & Perrett, 2013).

Imitation might be particularly relevant for learning displays rules, making facial expression of emotions culturally appropriate (Whiten et al., 1999), and for learning to communicate intentional messages through facial expressions (Williams et al., 2013). Therefore, imitation could be a relevant process in the development of both spontaneous and posed facial expressions of emotion.

### **1.1.3. Relevance of emotion recognition and expression**

Emotion recognition and expression are key aspects of social interaction. This thesis aims to investigate emotion recognition and expression in people with ED. Thus, the relevance of these processes for social interaction is reviewed.

#### *1.1.4.1. Relevance of emotion recognition*

The ability to recognise emotions in others is crucial for social interaction, and has been associated to emotional intelligence (Elfenbein & Marsh, 2002) and empathy (Blair, 2005). It can help individuals respond to the demands of others. For example, a person who recognises that a friend is sad can provide comfort and support, increasing the bond in the relationship (Matsumoto et al., 2008). Recognising emotions can provide valuable information to decide a course of action. For example, a person may decide to stop arguing with another after noticing signs of anger (Blair, 2003). Also, recognising emotions can help someone to take advantage of opportunities of their environment. For example, when trying to seduce someone, being able to recognise signs of happiness is relevant to evaluate the level of interest of the other person (Matsumoto et al., 2008).

Difficulties recognising emotions have been found in people with psychopathology. For example, it has been shown that individuals with schizophrenia and autism spectrum disorder have difficulties recognising basic emotions (Domes, Schulze, & Herpertz, 2009; Humphreys, Minshew, Leonard, & Behrmann, 2007; Kohler, Walker, Martin, Healey, & Moberg, 2010).

#### *1.1.4.2. Relevance of emotion expression*

Expressing emotions in a culturally appropriate manner has relevant social value (Schmidt & Cohn, 2001). Expressing emotions is essential for establishing rapport (Tickle-Degnen, 2006), deepening people's sense of connection and alliance during social interaction (Schmidt & Cohn, 2001). Even the expression of negative emotions can have positive effects on the establishment and maintenance of social relationships (Graham et al., 2008).

People who show a reduced facial expression of emotions tend to be judged as reserved and unhappy (Bogart, Tickle-Degnen, & Ambady, 2014; Tickle-Degnen & Lyons, 2004), and to have difficulties making friends (Hemmesch, Tickle-Degnen, & Zebrowitz, 2009).

Moreover, reduced facial expression has been linked to negative responses from partners (Krause, Steimer-Krause, & Hufnagel, 1992), health practitioners (Tickle-Degnen & Lyons, 2004) and people in general (Bogart et al., 2014).

Some psychiatric disorders, like depression and schizophrenia have been associated to flat affect and reduced emotion expression (Treméau et al., 2005).

## **1. 2. EATING DISORDERS**

Eating disorders (ED) are psychiatric illnesses characterized by significant problems in eating behaviour, and by excessive concern about body shape and weight (Association, 2000). In the past, ED referred to anorexia (AN) and bulimia nervosa (BN); however, the introduction of the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (APA, 2013) modified the name of this group of illnesses, changing it to ‘feeding and ED’.

The new ‘feeding and ED’ group comprises seven pathologies: pica, rumination disorder, avoidant/restrictive food intake disorder, AN, BN, binge-eating disorder, other specified feeding or ED, and a residual category named unspecified feeding or ED. This thesis focuses exclusively on AN and BN, and thus only these two disorders will be described in detail. The term ED will be used in its previously established fashion, to refer to AN and BN.

### **1.2.1. Diagnosis and epidemiology**

#### *1.2.1.1. Anorexia Nervosa (AN)*

AN is characterised by a restriction of food intake, leading to low body weight, an intense fear of gaining weight, and disturbances in the perception of body shape (APA, 2013).

**Table 1.4. Diagnostic criteria for AN**

Diagnostic criteria according to DSM-IV	Diagnostic criteria according to DSM-5
<p>A. A refusal to maintain body weight at or above a minimally normal weight for age and height (e.g. weight loss leading to a maintenance of body weight less than 85% of that expected, or failure to make expected weight gain during period of growth, leading to body weight less than 85% of that expected).</p> <p>B. Intense fear of gaining weight or becoming fat, even though underweight.</p> <p>C. Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight.</p> <p>D. In postmenarcheal females, amenorrhea, i.e. the absence of at least three or more consecutive menstrual cycles. (A woman is considered to have amenorrhea if her periods occur only following hormone, e.g. oestrogen, administration).</p> <p>Subtypes:  Restricting type: During the current episode of Anorexia Nervosa, the person has not regularly engaged in binge-eating or purging behaviour (i.e. self-induced vomiting or the misuse of laxatives, diuretics or enemas)  Binge-eating/purging type: During the current episode of Anorexia Nervosa, the person has regularly engaged in binge-eating or purging behaviour (i.e. self induced vomiting or the misuse of laxatives, diuretics or enemas).</p>	<p>A. Restriction of energy intake relative to requirements, leading to a significantly low body weight in the context of age, sex, development trajectory, and physical health. <i>Significantly low weight</i> is defined as a weight that is less than minimally normal or, for children and adolescents, less than minimally expected.</p> <p>B. Intense fear of gaining weight or of becoming fat, or persistent behaviour that interferes with weight gain, even though at a significantly low weight.</p> <p>C. Disturbances in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or persistent lack of recognition of the seriousness of the current low body weight.</p> <p>Subtypes:  Restricting type: During the last 3 months, the individual has not engaged in recurrent episodes of binge eating or purging behaviour (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas). This subtype describes presentations in which weight loss is accomplished primarily through dieting, fasting, and/or excessive exercise.  Binge-eating/purging type: During the last 3 months, the individual has engaged in recurrent episodes of binge eating or purging behaviour (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas).</p>

Source: American Psychiatric Association (2000; 2013)

Table 1.4 describes DSM-IV and DSM-5 criteria for AN. As it can be seen, DSM-5 modified DSM-IV criteria of AN. Main changes include the modification of the wording of criterion A, so that individuals no longer need to articulate a refusal to maintain a healthy weight, but behavioural evidence is sufficient to fulfil the criterion. In addition, the new criteria removed a definite marker of underweight status, acknowledging individual differences in the definition of healthy weight. Finally, criterion D (amenorrhea) was removed, to take into account the lack of this symptom in males, pre-pubertal females and females using contraceptives (APA, 2013).

AN is much more common in women than men, with a 10:1 female to male ratio (APA, 2013). In a review of epidemiological studies in ED using the new DSM-5 criteria, the incidence of AN among adolescent girls was estimated in 4.9 per 1000 person-year, and the lifetime prevalence ranged from 0.8% to 4.2% (Smink, van Hoeken, & Hoek, 2013). The course of the illness is thought to be less affected by the changes in diagnostic criteria, with around 50% of patients recovering (Smink et al., 2013), 20% remaining chronic (Steinhausen, 2002), and an annual mortality rate of 5 per 1000 person-years of follow up, mostly due to suicide (Arcelus, Mitchell, Wales, & Nielsen, 2011).

#### *1.2.1.2. Bulimia Nervosa (BN)*

The main feature of BN is the presence of recurrent episodes of binge eating, followed by compensatory behaviours such as fasting, excessive exercise, or purging (APA, 2013).

**Table 1.5. Diagnostic criteria for BN**

Diagnostic criteria according to DSM-IV	Diagnostic criteria according to DSM-5
<p>A. Recurrent episodes of binge eating. An episode of binge eating is characterised by both of the following:</p> <ol style="list-style-type: none"> <li>1. Eating, in a discrete period of time (e.g. within any 2- hour period), an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances.</li> <li>2. A sense of lack of control over eating during the episode (e.g. a feeling that one cannot stop eating or control what or how much one is eating).</li> </ol> <p>B. Recurrent inappropriate compensatory behaviour in order to prevent weight gain, such as self-induced vomiting; misuse of laxatives, diuretics, enemas or other medications; fasting; or excessive exercise.</p> <p>C. The binge eating and inappropriate compensatory behaviours both occur, on average, at least twice a week for 3 months.</p> <p>D. Self- evaluation is unduly influenced by body shape and weight.</p> <p>E. The disturbance does not occur exclusively during episodes of anorexia nervosa.</p> <p>Subtypes:</p> <p>Purging type: during the current episode of Bulimia Nervosa, the person has regularly engaged in self-induced vomiting or the misuse of laxatives, diuretics or enemas.</p> <p>Non-purging Type: during the current episode of Bulimia Nervosa, the person has used other inappropriate compensatory behaviours, such as fasting or excessive exercise, but has not regularly engaged in self-induced vomiting or the misuse of laxatives, diuretics or enemas.</p>	<p>A. Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following:</p> <ol style="list-style-type: none"> <li>1. Eating, in a discrete period of time (e.g., within any 2-hour period), an amount of food that is definitely larger than what most individuals would eat in a similar period of time under similar circumstances.</li> <li>2. A sense of lack of control over eating during the episode (e.g., feeling that one cannot stop eating or control what or how much one is eating).</li> </ol> <p>B. Recurrent inappropriate compensatory behaviours in order to prevent weight gain, such as self-induced vomiting; misuse of laxatives, diuretics, or other medications; fasting; or excessive exercise.</p> <p>C. The binge eating and inappropriate compensatory behaviours both occur, on average, at least once a week for 3 months.</p> <p>D. Self-evaluation is unduly influenced by body shape and weight.</p> <p>E. The disturbance does not occur exclusively during episodes of anorexia nervosa.</p>

Source: American Psychiatric Association (2000; 2013)

As it can be seen in table 1.5, most of the DSM-IV criteria for BN remained unaltered in DSM-5. The changes were related to the frequency of episodes of bingeing and purging (Criterion C), which was reduced from twice a week to once a week; and the removal of subtypes for BN (APA, 2013).

Like AN, BN affects largely women, with a 10:1 female to male ratio (APA, 2013). The incidence and lifetime prevalence for the new DSM-5 criteria for BN have been calculated as 3 per 1000 person-years and 2%, respectively (Smink et al., 2013). Recovery rates considering the new diagnostic criteria have been estimated in around 50%, which similar to those of the era of DSM-IV, supporting the idea that the changes in diagnostic criteria will not alter the course of ED (Smink et al., 2013). Annual mortality rate has been calculated as 1.7 per 1000 person-years of follow up (Arcelus et al., 2011), with suicide being the most common cause of death (Preti, Rocchi, Sisti, Camboni, & Miotto, 2011).

The diagnosis of ED is highly unstable, and nearly a third of people diagnosed with AN eventually crosses-over to BN. Cross-over from BN to AN is less common (Anderluh, Tchanturia, Rabe-Hesketh, Collier, & Treasure, 2009; Eddy et al., 2008).

It has been estimated that ED affect 1.6 million women and men in the UK, with a cost of £70 million to the National Health Service (NHS) (BEAT, 2012).



### **1.2.2. Comorbidity**

ED are highly comorbid with other psychiatric illnesses. Up to 68% of AN and 63% of BN patients have been found to have a lifetime diagnosis of major depressive disorder (Brewerton et al., 1995; Halmi et al., 1991). Another frequent comorbidity is anxiety disorders, with up to 65% of ED patients having a lifetime diagnosis (Kaye, Bulik, Thornton, Barbarich, & Masters, 2004; Swinbourne et al., 2012). According to the largest study to date, the most common comorbidities are obsessive-compulsive disorder (35% for AN, 40% for BN) and social phobia (now named social anxiety disorder) (22% for AN, 16% for BN) (Kaye et al., 2004). Finally, it has been reported that around 23% of adults with AN might also meet full diagnostic criteria for autism spectrum disorder (ASD) (Gillberg, 1983; Huke, Turk, Saeidi, Kent, & Morgan, 2013).

### **1.2.3. Emotions and ED**

The relevance of emotional difficulties in ED has been discussed since their initial descriptions in the medical literature. For example, in 1873 Lasègue noted that AN occurs in young women who “suffer from some emotions she avows or conceals” (cited in Vandereycken & van Deth, 1990, p. 904). But it was the pioneer work of Hilde Bruch and Mara Selvini Palazzoli that highlighted the role of emotional disturbances in people with AN, arguing that the disorder is related to underlying deficits in the sense of self (Bruch, 1982; Selvini, 1961).

Bruch (1962) identified three areas of psychological disturbances in people with AN: disturbance of body image, including the absence of concern about emaciation and denial of the illness; disturbances in the perception or cognitive interpretation of stimuli arising in the body, such as the inability to recognise hunger, fatigue, and emotional states; and a

sense of ineffectiveness in which the patients experience themselves as acting only in response to other people's demands (Bruch, 1962, 1965). According to Bruch's developmental model, many families of patients with AN had difficulties being responsive to the patient's needs since early childhood. Parents tended to demand full conformity and obedience, leaving little room for autonomy. Noteworthy, Bruch noted that the expression of feelings was not encouraged within these families (Bruch, 1982). According to the model, when children raised under those conditions reach adolescence, they lack awareness of their resources and do not rely on their feelings, thoughts and bodily sensations, which difficult the achievement of self-reliance independence and may translate into the deficits that are characteristics of AN (Bruch, 1973).

Selvini (1961), on the other hand, proposed that the helplessness of the ego was central to the development of AN. According to Selvini the development of AN originates in early difficulties in the mother-child relationship, which affect the child's sense of worth and security (Selvini, 1961). Selvini noted that most mothers of AN patients were typically seen as aggressive and unresponsive (Selvini, 1978). She argued that the child introjects this disturbed relationship as a "bad mother" and this negative connotation is generalised to body and food (Selvini, 1961). Thus, the body becomes a source of unpleasant and bad feelings, producing an impaired perception of the self. When facing adolescence, the need to discover a new self raises overwhelming feelings of helplessness. The ego copes with these feelings by rejecting the body and food, resulting in rigid control of the patient's body (Selvini, 1978).

In recent years, a series of new models have highlighted the role of emotion disturbances in the aetiology and maintenance of ED, which have informed the development of new treatment strategies focusing on emotional aspects of the ED, and inspired research investigating problematic emotion processing in people with AN and BN. Some of these newer developments are reviewed in this section.

#### *1.2.3.1. Emotional maintenance models of ED:*

##### *1.2.3.1.1. Cognitive-interpersonal maintenance model of AN (Schmidt & Treasure, 2006; Treasure & Schmidt, 2013)*

The cognitive-interpersonal model of AN proposes intrapersonal and interpersonal factors that help maintaining AN, including factors of emotional nature, such as emotion avoidance (Schmidt & Treasure, 2006).

According to the model, in early stages of AN, dietary restriction is reinforced both interpersonally and intrapersonally. Initial weight loss is usually praised by close others who may compliment the individual for the efforts (Branch & Eurman, 1980). In addition, dietary restriction can produce a sense of mastery and control (Fairburn, Shafran, & Cooper, 1999), along with a temporary improvement in mood and wellbeing. This way, the individual develops positive beliefs about starvation, and becomes more engaged in dietary rules and rituals (Schmidt & Treasure, 2006).

As weight loss increases, eating begins to arouse undesirable physical consequences, such as feeling nauseous, bloated or over satisfied (Keys, Brozek, & Henschel, 1950). Thus, the individual starts perceiving eating as physically and emotionally threatening, increasing the rigidity of the ED behaviours. In this phase thoughts about food and eating increase, consuming much of the individual's cognitive load. As a result, the person becomes disconnected from emotions and feels numb. This contribute to the development of more positive beliefs about the ED, such as the idea that AN helps coping

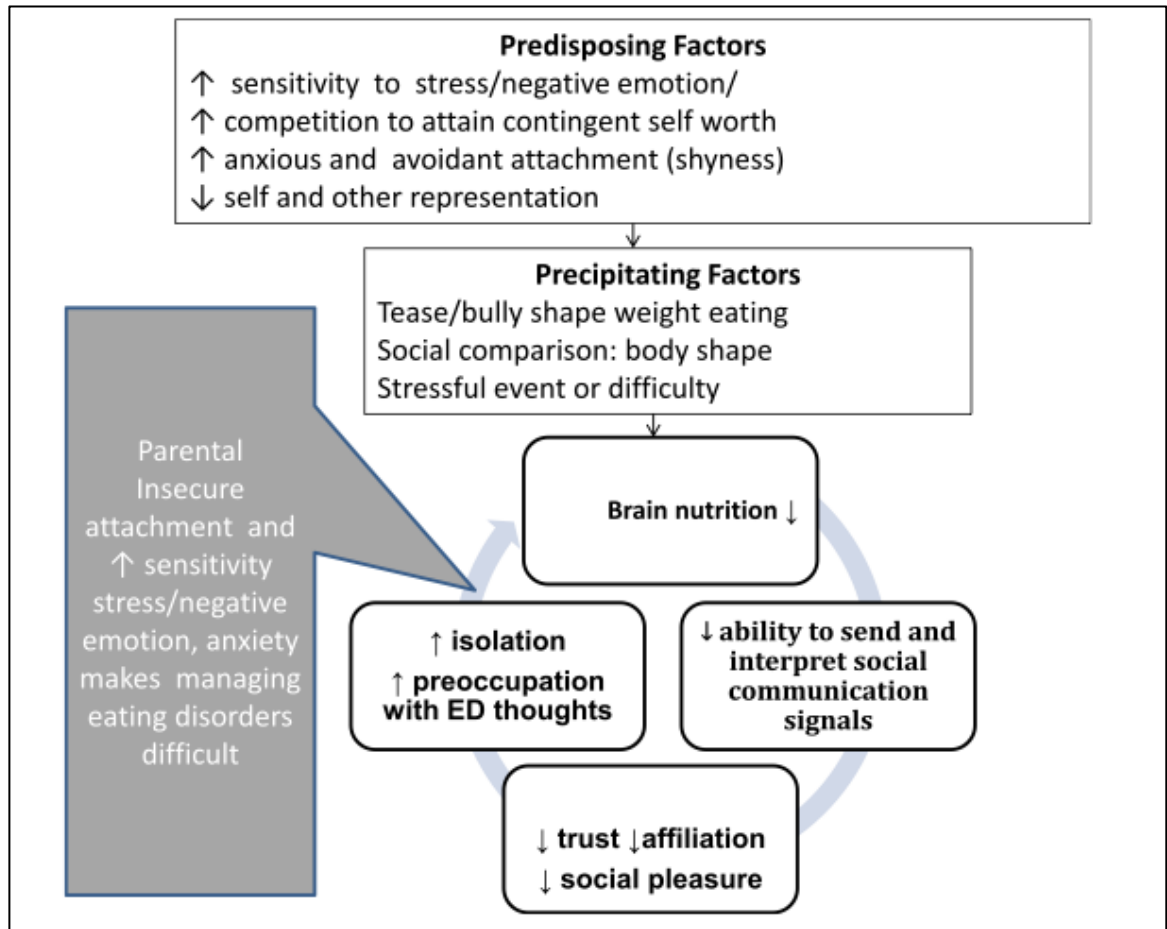
with emotions and to remain in control (Serpell, Teasdale, Troop, & Treasure, 2004; Serpell, Treasure, Teasdale, & Sullivan, 1999).

As extreme weight loss becomes more evident, close others become concerned about the individual's declining physical state, which may result in an increase in attention and care towards the person. This interpersonal pattern reinforces more positive beliefs about the disorder, such as the idea that AN makes them more attractive and special (Serpell et al., 1999). On the other hand, the AN may result in confrontation and hostility among close others. In this scenario, the usual response of the person with AN is to isolate, to avoid the negative emotions and criticism (Treasure, Crane, McKnight, Buchanan, & Wolfe, 2011). Social relationships are seen as threatening, which reinforces the idea that the ED is more dependable and safe than anything or anyone else (Schmidt & Treasure, 2006).

This model is supported by evidence that people with AN have a cognitive style characterised by difficulties in set shifting (Lang, Stahl, Espie, Treasure, & Tchanturia, 2014; Roberts, Tchanturia, & Treasure, 2010) and weak central coherence in AN (Lang, Lopez, Stahl, Tchanturia, & Treasure, 2014). Moreover, the socio-emotional traits that are thought to underpin social avoidance in people with AN have received empirical support (Figure 1.2). For example, increased attention to social threat and decreased attention to social reward (Cardi, Di Matteo, Corfield, & Treasure, 2013; Harrison, Sullivan, Tchanturia, & Treasure, 2010; Harrison, Tchanturia, & Treasure, 2010), problems in emotion recognition (for a review, see Oldershaw et al., 2011), reduced emotional expression (Davies, Schmidt, Stahl, & Tchanturia, 2011), problems understanding the mental state of others (i.e., theory of mind) (Oldershaw, Hambrook, Tchanturia, Treasure, & Schmidt, 2010; Russell, Schmidt, Doherty, Young, & Tchanturia, 2009) and alexithymia (for a review, see Nowakowski, McFarlane, & Cassin, 2013).

Based on this model, it can be inferred that people with AN have difficulties in emotion recognition and emotion regulation that may contribute to the maintenance of the disorder.

**Figure 1.2. Socio-emotional maintaining factors of ED**



Diagrammatic formulation of social processing traits showing how they predispose to and increase the vulnerability to precipitating factors and also perpetuate the ED.  
Source: Treasure & Schmidt (2013)

#### 1.2.3.1.2. Emotion acceptance behaviour therapy model of AN (EABT) (Wildes & Marcus, 2011)

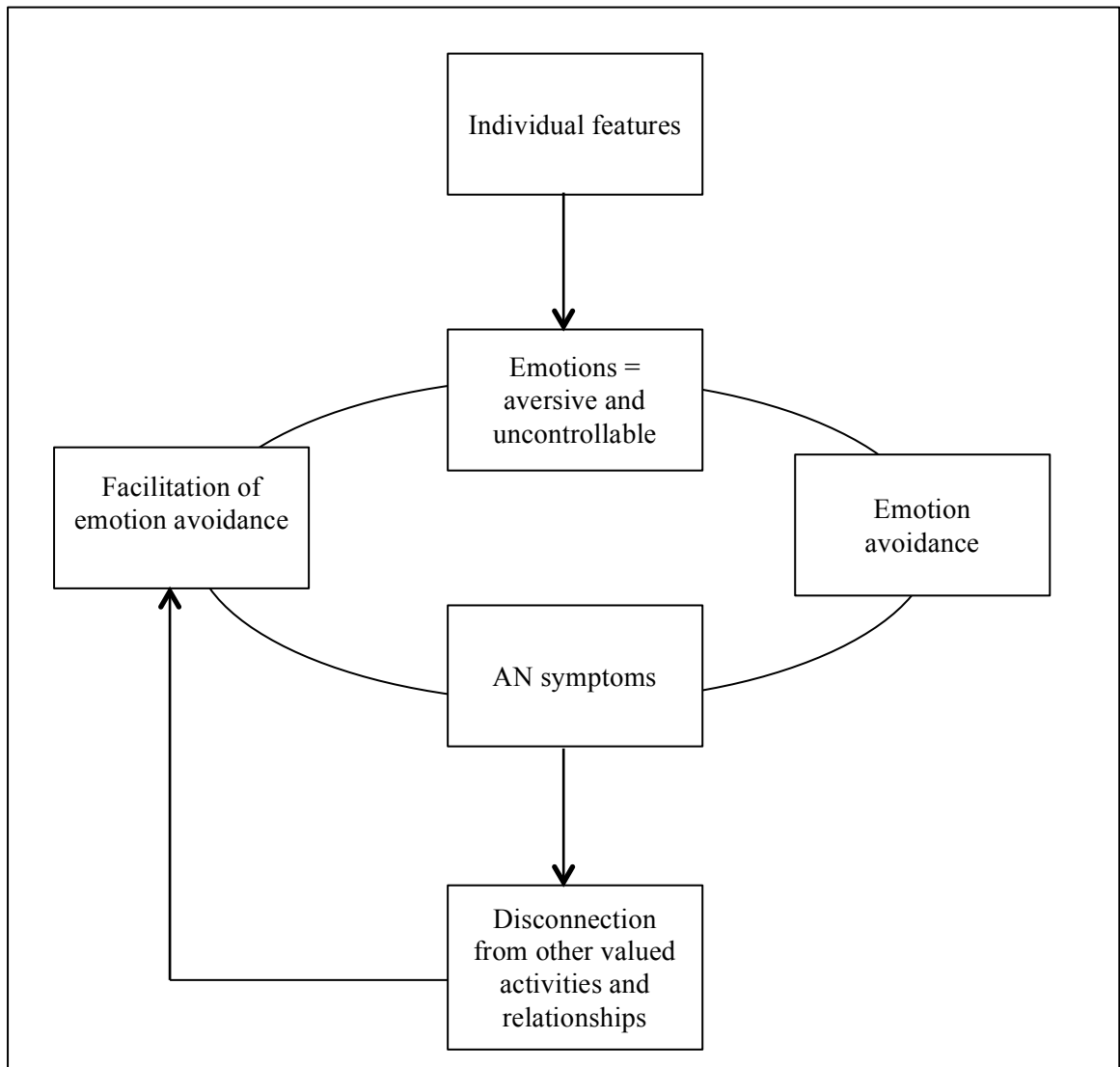
The EABT model was conceived to serve as a theoretical framework for the emotion acceptance behaviour therapy of AN (which will be reviewed in this section). This model postulates that AN symptoms serve an emotion avoidance function in people with AN, helping them cope with negative emotions, and comorbidities, such as depression and anxiety (Figure 1.3) (Wildes & Marcus, 2011; Wildes, Ringham, & Marcus, 2010).

People with AN usually experience high levels of anxiety and depression, and are characterised by inhibited or harm avoidance personality traits (Strober, 2004; Treasure, 2007). These characteristics influence the way they experience emotions, perceiving them as aversive and uncontrollable. The need to cope with comorbid mood disturbances results in emotion avoidance, which is defined as ‘the desire to avoid experiencing or expressing physical sensations, thoughts, urges and behaviours related to emotional states’ (Wildes & Marcus, 2011, p. 421)

According to this model, individuals may engage in AN symptom (e.g., extreme dietary restraint, purging, excessive exercise, ruminative thoughts about eating, shape, or weight) as a means to avoid experiencing emotions and/or to reduce the intensity and duration of emotional reactions. In the short term, these symptoms may be effective reducing emotion, but in the long term a paradoxical effect is produced (Hayes, Wilson, Gifford, Follette, & Strosahl, 1996), and the efforts to avoid emotions result in an increase of the frequency and intensity of emotional reactions. In addition, the excessive attention to ED symptoms prevents the person from focusing on other areas of their life, neglecting other life goals (Wildes & Marcus, 2011).

In support of this model, patients with AN have shown high levels of emotion avoidance (Wildes et al., 2010), and urges to restrict their eating in response to negative emotions (Wildes, Marcus, Bright, & Dapelo, 2012).

**Figure 1.3. EABT model of AN**



Source: Wildes & Marcus (2011)



Alike the cognitive-interpersonal maintenance model of AN, the EABT model sees emotion avoidance as a key factor in the maintenance of AN. But, the EABT model also emphasises the role of comorbidities, such as depression and anxiety, linking them to emotion avoidance.

Because emotion expression is conceived as part of emotion avoidance (Wildes & Marcus, 2011), it could be inferred from this model that people with AN have difficulties expressing emotions. In addition, it can be inferred that depressive and anxiety symptoms may be associated with emotion expression in AN.

#### 1.2.3.1.3. The mentalising model of AN (Skarderud, 2007a, 2007b, 2007c)

This model emphasises the role of problems in mentalising in the maintenance of AN. Mentalising has been defined as the ability to envision mental states in self and others. The term mental state is used to describe all mental experience: thoughts, emotions, motives, beliefs and intentions (Fonagy, 1991). Mentalising is a form of emotional knowledge (Allen, 2006) because being able to interpret, express, and regulate emotions require the ability to think about one's own thoughts and feelings (Soderstrom & Skarderud, 2009).

According to Fonagy (2006) individuals who are neglected in early relationships where their emotional experience is not adequately mirrored by the caregiver, develop a fragile capacity to represent mental states and affect. In the case of AN, it has been proposed that the ability to mentalise is not fully developed in part because of difficulties distinguishing the physical experience from the mental experience (Skarderud, 2007c). It is stated that in people with AN, physical sensations such as hunger, body size, shape and weight represent mental experiences, usually related to emotions (Skarderud, 2007a).

The model is influenced by the work of Lakoff and Johnson (1980), who use of the concept of ‘metaphors’ as a model for mental functioning. In this context, it is proposed that in AN the body can be seen as a metaphor in which emotional experiences are organised and felt, based on different domains of physical life (Skarderud, 2007a). For example, it was found in a qualitative study that AN patients assign different meanings to weight loss and ED behaviours, such as corresponding the physical sensation of ‘feeling heavy’ with negative feelings of ‘being burdened’. Therefore, in this case, losing weight (therefore becoming lighter) is a relief not only for the unpleasant physical sensation but also for the emotional experience (Skarderud, 2007a). Problems in mentalising can be identified in this example, because the patient is unable to distinguish the physical from the psychological experience (Skarderud, 2007b). As a consequence, people with AN often develop difficulties in interpreting and regulating their own affects, in interpreting other peoples emotions, and in perceiving and interpreting their own corporeality (Skarderud, 2007c).

In addition to qualitative studies (Espeset, Gulliksen, Nordbo, Skarderud, & Holte, 2012; Skarderud, 2007a), experimental studies showing difficulties in emotional theory of mind provide support for this model (for a review, see Oldershaw et al., 2011; Tchanturia, Dapelo, Harrison, & Hambrook, 2015). A recent systematic review on attachment and mentalization in adolescents with ED also concluded that adolescents with ED have difficulties mentalising (Jewell et al., 2015).

Based on this model, it can be inferred that people with AN have difficulties recognising emotions in self and others, expressing and imitating emotions.

#### 1.2.3.1.4. Radically open-dialectical behaviour therapy model of AN (RO-DBT) (Lynch, Hempel, & Dunkley, 2015)

The RO-DBT model is a transdiagnostic model on the emotional basis of overcontrol and is applicable not only to AN, but also to other disorders characterised by overcontrol, such as obsessive-compulsive disorder (Lynch et al., 2015). It proposes that in AN (particularly the restricting subtype), symptoms like food restriction and ritualised eating function as a form of maladaptive overcontrol. In this model, emotional loneliness represents the core problem for overcontrol at the basis of AN (Lynch et al., 2015).

According to RO-DBT, people with AN have temperamental characteristics, such as biases for heightened threat and diminished reward sensitivity, which in conjunction with family/environmental experiences that condemn mistakes and value self-control, can promote the development of overcontrol. People with AN use ED behaviours as an emotion regulatory strategy, numbing emotional expressions. Frozen or disingenuous expressions, long silences, and inner masking feelings become the rule in social interactions, causing other people to perceive them as inauthentic, leading to social ostracism and loneliness (Lynch et al., 2015).

Similar to the previous models, RO-DBT emphasises the function of AN, as a means to manage emotions that are perceived as aversive or threatening. However, this model is more explicit in describing the consequences of overcontrolled emotion expression in social functioning.

It can be inferred from this model that people with AN exhibit reduced expression of emotions, leading to difficulties in social functioning and loneliness.

#### 1.2.3.1.4. Dual-pathway model of BN (Stice, 2001)

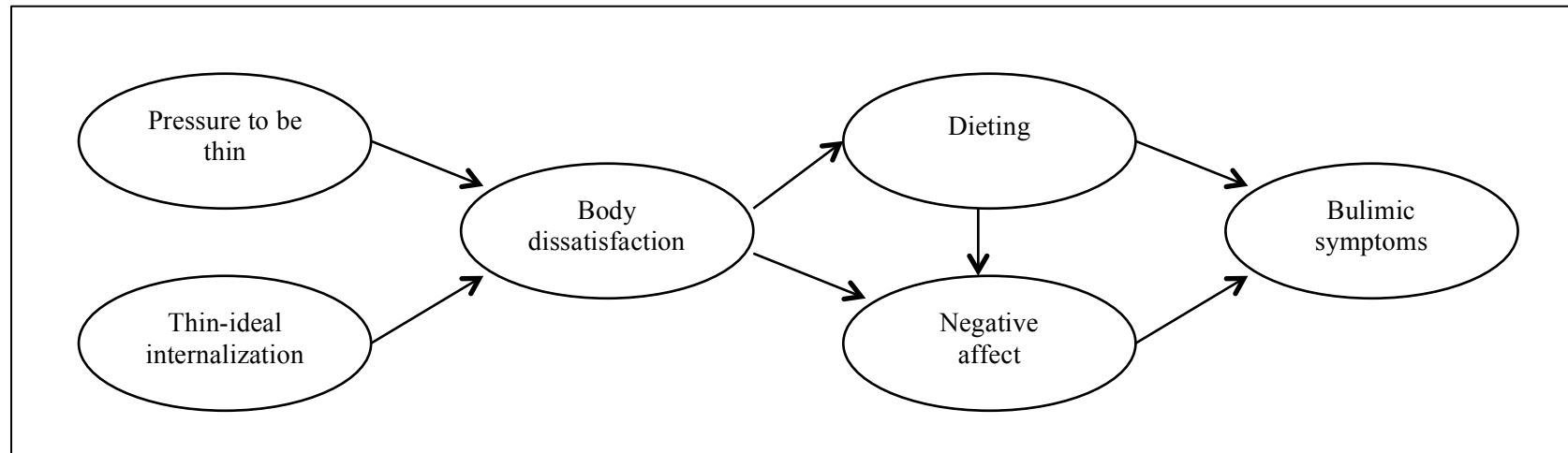
The dual-path model links BN directly with emotional disturbances. It proposes that people may initiate bulimic behaviours, such as bingeing and purging, because of either extreme dieting or chronic negative affect, or a combination of these factors (Figure 1.4) (Stice, 2001).

In this model, the internalisation of cultural ideals of thinness and pressure to be thin from family, peers, and the media influence the individual, provoking dissatisfaction towards one's body. This increased body dissatisfaction elicits negative feelings and promotes the engagement in weight-control behaviours like dieting (Stice, 2002). Extreme dieting can increase negative affect because of the effects of starvation on mood. In addition, dieting tends to lead to binge eating, which increases negative affect because the individual feels like she failed to commit to the diet. Finally, negative affect can also increase BN symptoms, because bingeing can provide short-term comfort and distraction from negative affect (Stice, 2001).

This model highlights negative affect as a key risk factor for BN. It can be inferred from the model that just like in the case of AN, BN symptoms, particularly binge eating, may serve a regulatory function, helping the person to cope with negative affect.

Even though the model does not provide information to make inferences about the importance of emotion recognition and expression in BN, the idea that BN symptoms can be used to cope with negative affect provide support for exploring emotion processing in BN.

**Figure 1.4. Dual-pathway model of BN**



Source: Stice (2001)

#### 1.2.3.1.5. The schematic propositional analogical associative representation system model of ED (SPAARS-ED) (Fox & Power, 2009)

The SPAARS-ED assumes a transdiagnostic view of ED, referring to both AN and BN. Fox and Power (2009) developed a conceptualisation of ED based on the schematic propositional analogical associative representation system model (SPAARS) (Power & Dalglish, 2008), in which ED are understood as ‘a powerful, maladaptive way to either manage painful emotions directly or to manage a poorly defined sense of self’ (J. R. E. Fox, Federici, & Power, 2012, p. 317).

The SPAARS-ED model states that people with ED have negative beliefs about themselves, along with a high regard of other’s approval. For example, “I am a failure” or “people’s approval is vital”. These beliefs are organised in socially oriented schemas that also include negative belief about the world, which is perceived as unsafe, and emotions, which are generally seen as a weakness or dangerous (Figure 1.5) (Fox, et al., 2012).

According to the model someone with these schemas might perceive thinness as an ideal that, if achieved, will be highly valued by others, protecting the individual from rejection. Therefore, the person engages in eating behaviours like dietary restraint in order to achieve thinness. However, the poor self-concept schemas with ideas like “I am not good enough” or “I am not thin enough” reinforce the need to control over food, which can lead to patterns of binge/purging behaviour. Negative emotions are elicited, such as sadness, self-disgust, and anger. These emotions are perceived by the individual as weakness, shameful or dangerous, activating mechanism to cope and regain control, which translates into more ED behaviours (Fox et al., 2012).

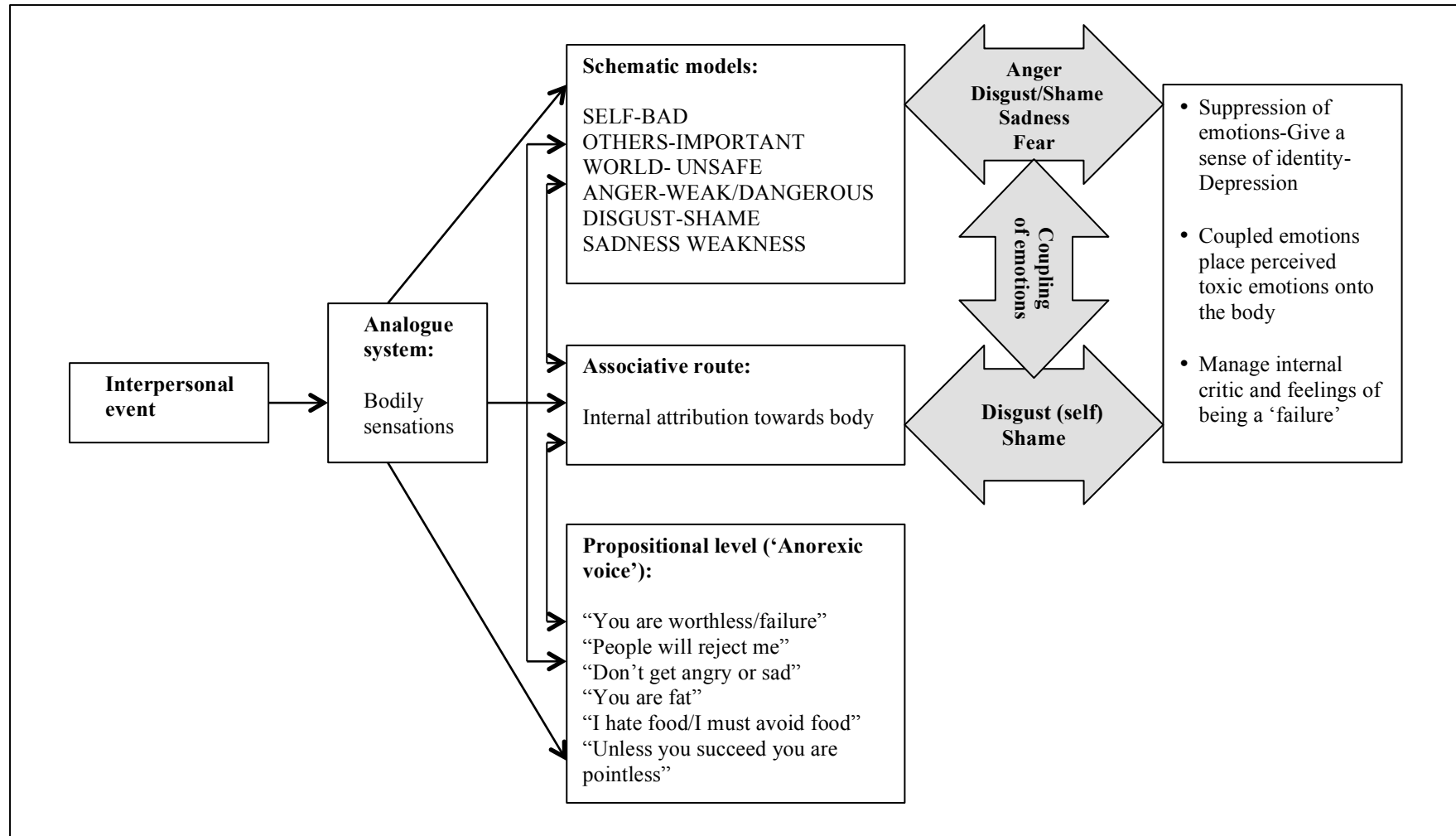
An important aspect of this model is emotion coupling. According to SPAARS, certain emotions that are particularly unacceptable for an individual may be inhibited and managed by other, more acceptable emotion. In the case of ED, the model poses that anger is perceived as particularly threatening and thus it may have become coupled with disgust through the course of development (Fox & Froom, 2009). This way, when a

person with ED feels anger, it tends to inhibit it and replace it by feeling disgust (Fox & Froom, 2009).

Findings from experimental studies in people with ED support this model, with evidence of higher levels of disgust after an anger induction (Fox & Harrison, 2008), and a negative association between emotion expression and ED symptoms (Ioannou & Fox, 2009).

Unlike the previous models, the SPAARS-ED is a transdiagnostic model, which highlights the role negative emotions (and beliefs about negative emotions) in the maintenance of both AN and BN. The model poses particular emphasis in two basic emotions: anger and disgust. It can be inferred from the model that people with both AN and BN process anger and disgust in a maladaptive fashion. Thus, people with ED may exhibit problems recognising and expressing these basic emotions.

**Figure 1.5. SPAARS-ED model**



Source: Fox, Federici & Power (2011)



1.2.3.1.6. Shame, pride, self-criticism and self-directed hostility as maintenance factors of ED: The compassion-focused treatment model of ED (CFT-E) (Goss & Allan, 2010)

Goss and Allan (2010) have proposed that shame, pride, self-criticism and self-directed hostility are relevant to understand the psychopathology of ED.

Shame is a multifaceted, self-conscious emotion that blends the different emotions of anger, anxiety and disgust (Gilbert, 1998). Gilbert (1998) describes two types of shame: internal shame, which involves evaluations that the self is flawed or bad in some way, and external shame, in which the person thinks that others are looking down on him/her.

A number of studies have found an association between shame and eating pathology (for a review see Goss and Allan, 2009) and it has been proposed that chronic feelings of shame could be both a risk factor and a consequence of AN (Skarderud, 2007d).

Self-criticism and self-directed hostility are closely linked to internal shame (Goss & Allan, 2010). Gilbert (2004) identified two functions of self-criticism: self-improvement and self-harming/self-persecuting. It has been proposed that people with ED criticise themselves more for the purpose of self-harming/self-persecution (Goss & Allan, 2014).

On the other hand, internal pride is the feeling of admiration and approval of one's own attributes and talents or being pleased with one's achievements (Mascolo & Fischer, 1995).

Goss and Gilbert (2002) suggest that in AN, a shame-pride cycle is developed, whereby internal and external shame lead to restriction, and the weight loss leads to feelings of pride, reinforcing the ED behaviour. In the case of BN, the authors propose the development of a shame-shame cycle in which feelings of shame lead to binge eat to regulate the affect, but both the binge eating and the compensatory behaviours perpetuate feelings of shame.

Based on these ideas, the compassion-focused treatment model of ED proposes that ED behaviours serve a functional purpose in attempting to regulate threat (Goss & Allan,

2014). The development of pride in ED behaviours (e.g., pride in losing weight) can be used to regulate the threat system (Goss & Allan, 2009).

The model suggests that people with ED, especially AN, are highly focused on dynamics where shame and pride (rather than affection or friendship) are the salient self-organizing motives (Goss & Gilbert, 2002), and it argues that, without access to the affiliative system, the drive/pride and threat systems often become interlinked, which can lead to vicious maintenance cycles (Goss & Allan, 2014).

This model highlights the relevance of emotion regulation in the development of an ED, which can have implications in emotion expression. In addition, it implies a tendency to interpret others as judgmental and hostile, which could be manifested in the misinterpretation of facial expressions.

#### *1.2.3.2. Treatments for ED with focus on emotions*

1.2.3.2.1. Maudsley model of anorexia nervosa treatment for adults with anorexia nervosa (MANTRA) (Schmidt et al., 2012; Wade, Treasure, & Schmidt, 2011)

MANTRA is based on the cognitive interpersonal maintenance model of AN. It aims to address maintaining factors such as rigid thinking style, emotion avoidance, pro-anorectic beliefs, and the response of close others (Wade et al., 2011). The treatment is delivered individually in 20 weekly sessions, using a motivational interviewing style along with more practical exercises (Schmidt et al., 2012).

There are four phases of treatment: During the initial phase, the patient is given information about his health risk and cognitive style, and the valued function of AN is explored. In the formulation phase, a treatment plan is developed. During the working for change phase, modules on socio-emotional impairments, thinking styles, and identity are

introduced. The final phase focuses on ending of treatment and relapse prevention (Schmidt et al., 2012).

This treatment addresses socio-emotional difficulties, such as problems in emotion recognition and expression, with a special emphasis on emotion avoidance.

1.2.3.2.2. Cognitive remediation and emotion skills training (CREST) (Davies et al., 2012; Money, Genders, Treasure, Schmidt, & Tchanturia, 2011; Tchanturia, Doris, & Fleming, 2014)

Cognitive remediation and emotion skills training is a 10 sessions, 45 minutes long, individual manualised treatment for inpatients with severe AN. CREST was developed with the purpose of targeting emotion processing, even though it has a minor focus on thinking styles as well (Money et al., 2011) The first 2 sessions focus on thinking styles, such as bigger picture thinking and cognitive flexibility. The following 8 sessions target emotions. Different psycho-educational modules and interactive exercises are designed to help individuals learn about (1) the function of emotions, (2) how to label and identify emotions in oneself and others, (3) the positive intentions of emotions and the needs emotions communicate to the self and others and (4) practise tolerating and expressing emotions (Davies et al., 2012). In these sessions, materials and tasks are used to facilitate reflection on current and new strategies to manage, tolerate and express emotions. The intervention is not related to eating, weight or shape concern and was intentionally designed to broaden the patient's perspective of their current state and focus on everyday emotional skills. Furthermore, the activities within the sessions are designed to be socially enjoyable, to inform patients about the components of social communication, and to assist them to develop more adaptive and improved social skills (Tchanturia et al., 2014).

This treatment focuses directly on emotion recognition and expression, with a particular emphasis in the expression of positive emotions, in order to improve social skills.

1.2.3.2.3. Emotion acceptance behaviour therapy (EABT) (Wildes & Marcus, 2011; Wildes, Marcus, Cheng, McCabe, & Gaskill, 2014)

Emotion acceptance behaviour therapy is a manualised, individual, outpatient psychotherapeutic intervention designed specifically for older adolescents and adults with AN (Wildes & Marcus, 2011). It is based on the EABT model.

The primary treatment targets in EABT are (1) AN symptoms, (2) emotion avoidance, and (3) disconnection from other valued activities and relationships. EABT combines behavioural interventions aimed at AN symptoms, such as weight monitoring and prescription of a healthy diet, with psychotherapeutic techniques designed to increase emotion awareness, decrease emotion avoidance, and encourage resumption of valued activities and relationships outside of the ED. EABT focuses on helping patients to identify the functions served by AN symptoms, including the connection between AN symptoms and emotion avoidance, and to adopt alternative strategies to cope with aversive emotions, such as cultivating a willingness to experience/tolerate uncomfortable emotions in the service of reconnecting with other valued activities and relationships (Wildes & Marcus, 2011).

EABT is divided into three phases. The first phase is focused on orienting the patient to treatment, building a therapeutic relationship and establishing goals. The second phase is focused on helping the patient to meet the goals using contextual and experiential strategies such as mindfulness, acceptance, and contact with the present moment. The third phase is focused on consolidation of achievements, end of treatment, and relapse prevention (Wildes & Marcus, 2011).

The main focus of this treatment is on emotion awareness and regulation; however, there is some emotion expression component in it, in the sense of helping the patient to accept emotions and their response (which includes facial and body expressions) and to regulate them to enhance social relationships.

#### 1.2.3.2.4. Mentalisation-based therapy for eating disorders (MBT-ED) (Robinson et al., 2014; Skarderud, 2007c)

The mentalisation-based therapy is based on the research on attachment and mentalising (e.g., Allen, 2006; Fonagy, 1991) and actively seeks to enhance mentalising abilities in the patient, with emphasis on both cognitive and emotional processes. A particular feature of MBT is that given the focus on mentalising, it works on the patients' own thoughts and feelings, but also on those of others (Skarderud, 2007c).

MBT has been mainly developed for borderline personality disorder (Bateman & Fonagy, 2004), but recently it has been adapted to ED, particularly for those patients who have common features with borderline personality disorder, such as self-injury (Robinson et al., 2014). This treatment is delivered in five introductory group sessions followed by one year of weekly group and individual sessions. The goal of MBT-ED is to provide a safe context and attachment experience within which the patient learns to mentalise, exploring his own mind, the one of the therapist, and other patients in the group (Robinson, 2014).

With a strong focus on the ability to reflect about one and other's mental states, this treatment targets emotion recognition in self and others and emotion regulation.

1.2.3.2.5. Radically open-dialectical behaviour therapy for anorexia nervosa (RO-DBT) (Lynch et al., 2013; Lynch et al., 2015)

RO-DBT is a transdiagnostic, manualised treatment designed to address a spectrum of disorders that share features associated with maladaptive over-control, such as AN (Lynch et al., 2015). It is based on the theoretical background described in the previous section.

The primary goal of the treatment is to decrease severe behavioural overcontrol. RO-DBT aims are (in order of importance): (1) to reduce life-threatening behaviours, (2) to repair alliance-ruptures, and (3) to reduce overcontrol maladaptive behaviours (Lynch et al., 2015).

The treatment is similar in structure to dialectical behaviour therapy (Linehan, 1993), involving weekly 1-hour long individual sessions, weekly skills training classes, telephone coaching and weekly therapist consultation team meeting. Skill training classes focus on core mindfulness, interpersonal effectiveness, emotion regulation, distress tolerance, and radical openness. The treatment targets emotion expression as a means to reduce loneliness and social isolation, with strategies to learn to signal cooperation, including changing body postures and facial expressions, encouraging genuine self-disclosure (Lynch et al., 2015).

This treatment focuses directly on emotion expression; with an emphasis is genuine expression of emotions.

1.2.3.2.6. Compassion-focused therapy for ED (CFT-E) (Goss & Allan, 2010, 2014)

CFT-E was developed to address shame, self-criticism, and self-directed hostility by helping people with ED to cultivate affiliative emotions and compassion (Goss & Allan, 2014). The aims of CFT-E are to develop compassionate states of mind as an alternative to the states of mind operating when the threat, drive, or pride systems are active,

particularly, more adaptive ways of managing threat within the emotions of compassion, warmth, and genuine care for the self (Goss & Allan, 2010).

CFT-E is delivered in a group format, and includes weekly weight checks and out-of-session individual telephone support (Goss & Allan, 2014). There are three stages of treatment:

Stage 1. Psychoeducation: This phase aims to help patients understanding how ED arise and how they are maintained (biologically, psychologically, and socially). Patients are encouraged to explore their ambivalence (threats) in relation to recovery, in particular the challenges of developing alternate coping strategies and the biological demands and consequences of normalizing their eating behaviours (Goss & Allan, 2010).

Stage 2. Capacity building: In this phase the value of self-compassion is outlined to patients. A series of strategies are used to aid patients to develop compassion and show compassion to and for each other. Some of these strategies are guided practice in compassionate imagery, compassionate letter writing, and compassionate attention, thinking, feeling, and behaviour to address the challenges of recovery from an ED. This helps patients developing the skills they will need during the recovery stage, including formulation skills, experiencing safeness, meal-planning, and identifying goals for recovery (Goss & Allan, 2010).

Stage 3. Recovery: Patients only access this phase of the program if they are motivated to make changes in their ED symptoms. The aim is to develop a compassionate approach to the challenges of recovery, including relapse prevention. The targets for treatment in this phase include normalizing eating and addressing ED beliefs and behaviours (Goss & Allan, 2010).

Through the developing of compassion for self and others, CFT-E aims to have an impact in emotion regulation, which could translate into a more open expression of emotions to others.

#### *1.2.3.3. Socio-emotional processing in ED*

The first studies on emotion processing in ED focused on alexithymia (i.e., difficulties identifying and communicating emotions) (e.g., Bruch, 1962; Pierloot, Houben, & Acke, 1988) demonstrating that both, people with AN and with BN exhibit high levels of alexithymia (for a review, see Nowakowski et al., 2013). Since then, many studies have focused on different aspects of socio-emotional processing in people with ED, which have been revised in two systematic reviews concluding that in general, when compared to healthy controls, people with ED show difficulties in the socio-emotional domain (Caglar-Nazali et al., 2014; Oldershaw et al., 2011).

##### *1.2.3.3.1. Social functioning in ED*

Loneliness and social isolation are common features of the experience of patients with ED, as it has been reported in qualitative studies (e.g., Robinson, Kukucska, Guidetti, & Leavey, 2015) and theoretical models (e.g., Treasure et al., 2011). People with ED, particularly AN, report difficulties establishing and maintaining friendship ties even before the onset of the ED (Doris, Westwood, Mandy, & Tchanturia, 2014). In addition, people with ED report a high impact of the disorder on social functioning (Tchanturia et al., 2013)

People with ED report high levels of social anhedonia, or a reduced drive to seek out and experience pleasure from social interactions (Harrison, Mountford, & Tchanturia, 2014). Experimental studies show that they direct their gaze less at the face and eyes (Watson, Werling, Zucker, & Platt, 2010), and have low sensitivity to reward (Cardi et al., 2013). In addition, people with ED show attentional biases towards angry expressions (Harrison, Sullivan, et al., 2010; Harrison, Tchanturia, et al., 2010) and to rejection and criticism (Cardi, Di Matteo, Gilbert, & Treasure, 2014).



#### 1.2.3.3.2. Emotion processing in ED

Next, a published review of the literature in emotional processing in people with ED is presented. The review was carried out with specific emphasis on positive emotions, as a way to highlight the relevance of investigating positive affect and its potential benefits for patients with ED. In addition, specific literature on emotion recognition and expression is further reviewed in the introduction of each study included in this thesis.

## **CHAPTER 1**

### **STUDY 1**

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#### **WHY STUDY POSITIVE EMOTIONS IN THE CONTEXT OF EATING DISORDERS?**

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# Why Study Positive Emotions in the Context of Eating Disorders?

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**Abstract** Experimental research, supported by systematic reviews, establishes that people with eating disorders have emotional difficulties in terms of recognising, regulating and expressing their emotions. These emotional difficulties contribute to poor social functioning and problems with relationships. The existing literature includes a broad range of studies, many of which have utilised self-report measures, but experimental studies of emotions in eating disorders are still limited. The primary aim of this paper is to highlight gaps in the clinical research on emotions in eating disorders, focusing on experimental investigations from our lab and highlighting potentially useful future directions for further basic research

and its translation into new developments in treatment and prevention. Recent findings using experimental paradigms to study the expression of emotions along with neuroimaging research exploring differences in facial emotion processing are discussed, and clinical implications are presented.

**Keywords** Eating disorders · Positive psychology · Experimental · Self-report · Emotions · Quality of life

## Introduction

Clinical and experimental psychologists have studied negative emotions such as anger, sadness, fear and disgust extensively for the past few decades. The field of eating disorders is no exception. Eating disorders (EDs), including anorexia nervosa (AN) and bulimia nervosa (BN), are mental health problems associated with impaired quality of life [1], high social anhedonia [2, 3] and a limited number of relationships [4•]. Recently, the number of studies reporting links between autistic spectrum disorders and anorexia has been growing [e.g. 5•, 6]. An increasing body of theoretical and empirical literature has begun to map the broad range of difficulties with emotional processing experienced by people with EDs [e.g. 7] and the tentative aetiological underpinnings of these emotional problems [e.g. 8], as well as implications for treatment.

The vast majority of existing research regarding emotional processing in people with EDs is associated with the ‘deficit’ or ‘disease model’ in clinical psychology and psychiatry. Such approaches actively seek to identify, explain and remedy deficits or abnormalities that might cause/be caused by ‘mental illness.’ In contrast, positive psychology research, spearheaded by Seligman [e.g. 9], Fredrickson [10] and Csikszentmihalyi [e.g. 11], highlights the importance of studying strengths, resources, resilience, optimism and hope, as a challenge to the deficit model of human experience. This

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paradigm shift from ‘fixing the problem’ to ‘exploring strengths’ has influenced research and practice in a wide range of applied psychological fields [e.g. 12]. This paper aims to explore the theoretical applications of positive psychology for ED prevention and treatment in the context of currently available experimental data.

### Positive Emotions and Their Implications for Eating Disorder Recovery

According to Fredrickson [10], ‘positive emotions serve as markers of flourishing, or optimal well-being’. Over a number of experiments, Fredrickson [10, 13] has demonstrated that positive emotions broaden our thought-action repertoires, can counteract/balance out negative emotions and build resilience [14, 15]. More specifically, the broadening effect of positive emotions facilitates the capacity to open up our minds, which helps us to ‘think outside the box’. This is a useful tool because it gives a ‘bigger picture’ view of our current situation, enabling humans to become more creative and flexible in finding alternative solutions to problems. Regarding EDs, Fredrickson’s findings [10, 13] may have implications for helping patients to move towards recovery. Thinking in terms of the ‘bigger picture’ in relation to goals around recovery is very important in EDs, particularly in AN where the illness is often ego-syntonic and many patients place high value on retaining the illness and its identity. Fredrickson’s findings [10, 13] suggest that patients may be able to make better decisions about their behaviours when experiencing some degree of positive emotion. The broadening effect of positive emotions has further important implications for EDs, as there is experimental evidence suggesting patients have difficulties with flexible and bigger picture thinking, as highlighted in a recent systematic review [16] despite the IQ of patients tending to be in the average to above average range [17]. Clinically, this information processing style is manifested by patients making decisions about their health based on small details [e.g. the calorie content of two food items], rather than the overall picture of their health and quality of life. It may be that working with patients to increase their daily experience of positive emotions might be one way of helping them to practise bigger picture thinking skills. Therefore, facilitating positive emotional states and broadening problem-solving skills seem highly relevant to the ED field.

Fredrickson’s work [10, 13] has led to a focus on 10 important positive emotions: joy, gratitude, serenity, interest, hope, pride, amusement, inspiration, awe and love. Her research demonstrates that enhancing our experience of these emotions can lead to greater psychological [and physical] well-being [10]. In addition, experimental research generated by the field of positive psychology demonstrates that writing letters of gratitude, performing kind acts, identifying and

cultivating strengths and visualising an ideal future all improve subjective happiness and well-being [18]. One implication these data have for the field of EDs, where patients have high levels of negative affect, might be that sharing these ideas with patients and coaching them to utilise these positive interventions in their daily lives might enhance their experience of positive emotion, allowing them to access better problem-solving strategies regarding their health behaviours. Therefore, it could be argued that the application of positive psychology is relevant in the realm of understanding and improving the well-being of people with EDs.

### Positive Psychology and Its Role in the Prevention and Treatment of Eating Disorders

Resilience-building programmes developed by researchers in the field of positive psychology, such as the Penn Resilience Programme [e.g. 19], have been successful in helping to prevent depression in young people, as highlighted in a meta-analysis by Brunwasser and colleagues [20]. It is possible that positive psychology could also play an important role in the prevention of EDs. For example, Gongora [21] reports that drive for thinness, physical activity and body dissatisfaction were lower in female adolescents who reported higher levels of positive emotion, engagement in life and having a meaningful life. Whilst research into risk factors has significantly increased our understanding of what contributes to the development of EDs [22, 23], and has intuitive appeal in terms of enabling us to ‘fix’ what is wrong, it unfortunately neglects the flip side of what is right. More pertinently, prevention programmes aimed at reducing risk factors have demonstrated small to moderate effect sizes in reducing the onset of EDs and maladaptive eating attitudes and behaviours [24]. The promotion of protective factors, as proposed by the positive psychology framework, could enrich prevention programmes, thus enhancing their impact.

Positive psychology interventions may also play an important role in treating clinical EDs, in the context that despite cognitive behavioural therapy being identified as an evidence-based treatment for BN [25], AN continues to be one of the most challenging disorders to treat, with no specific treatment approach showing superiority for adult populations [26, 27]. A focus on the patient’s strengths and resources, as proposed by positive psychology, could enhance the effectiveness of current treatments. Indeed, some of the so-called third wave cognitive and behavioural psychological therapies have made attempts to apply emotion-focused interventions to an ED population. For example, compassion-focussed therapy, which among other components, focuses on enhancing skills of self-soothing and compassion towards the self, has already demonstrated some positive early outcomes as an intervention for people with EDs [28]. The same is true for acceptance and

commitment therapy [e.g. 29] and emotion acceptance behaviour therapy for AN [30], both of which involve components focusing on identifying and enhancing patients' resources and increasing the presence of positive emotional experiences. Finally, cognitive remediation and emotion skills therapy (CREST), which was developed specifically for patients with AN [31, 32], is a manualised treatment shown to be acceptable to patients [31, 32] and involves a social-emotional module [33], which focuses not only on helping patients to understand and manage emotions but also on increasing the presence of positive emotion in their life through positive psychology interventions like writing down three good things noticed each day.

It is argued here that the application of a positive psychology framework, directed towards the promotion of factors that protect against illness and utilise strengths to promote recovery from disordered eating, could represent a necessary, plausible and recovery-focused shift away from the disease model and a move towards holistic wellness.

In this context, the next section of this paper presents a review of the existing and emerging research literature regarding emotional processing in people with EDs. The review will highlight potential emotional processing strengths, as well as interesting future directions for research and clinical intervention and prevention programmes, relevant to EDs.

### Emotional Intelligence in EDs

To our knowledge, only one study has explored emotional intelligence in people with EDs [34•]. Using the Mayer-Salovey-Caruso Emotional Intelligence Test [MSCEIT; 35], Hambrook and colleagues identified problems in this domain in a group of AN participants. Other studies have focused on more specific aspects of emotional processing in EDs, such as perception and recognition of emotions, neural correlates of emotion processing, and expression of emotions, and these data are reviewed below.

### Perception of Positive Emotions in EDs

Oldershaw and colleagues [7] conducted a comprehensive systematic review and meta-analysis of the available experimental research exploring emotional processing in people with AN. Experimental work was chosen because the evidence base utilising this methodology was limited and less clear than research involving self-report measures. Oldershaw and colleagues concluded that emotional recognition had received the most attention, and it was possible to appraise the evidence in this domain, unlike in other areas of emotional processing. An update of the literature follows, with a specific

focus on the recognition of basic and complex positive emotions in individuals with EDs.

### Basic Emotion Recognition

Early studies exploring basic emotion recognition in the ED population reported on the overall performance of participants without distinguishing between positive and negative emotions and produced mixed findings [36, 37]. Since then, most studies have looked at the how accurate ED patients are at identifying specific emotions separately (i.e. happiness, sadness, anger, etc.) (see Table 1 for all available studies). With only one exception [38], all these studies show different levels of performance for positive and negative emotions. Whilst the results for negative emotions are generally mixed, there is consistent evidence that ED participants do not differ from healthy controls (HCs) in their ability to recognise happiness in faces [39–44].

### Emotional Theory of Mind

Originally designed as a measure of theory of mind (ToM), the Reading the Mind in the Eyes (RME) task [45] has been used to investigate complex emotional recognition, or emotional theory of mind (the ability to infer the emotional state of others). Even though most studies using this task report data from ED patients in the form of overall performance results (i.e. the ability to correctly identify emotions *per se*) [46–54], four studies to date have explored the effect of valence (positive/negative emotions) on participants' performance. These studies exhibit mixed results (see Table 2 for all available studies). For example, Oldershaw and colleagues [55] found that patients with AN performed more poorly than HC participants in identifying both positive and negative emotional states, suggesting a valence non-specific difference in the ability to infer emotion in others. In contrast, Tapajoz and colleagues [56] found no problems in identifying positive states by people with AN compared to HCs, but worse performance in identifying negative states. Medina-Pradas and colleagues [57] found AN participants demonstrated equivalent performance to HCs when identifying both positive and negative emotional states on the RME. Results are similarly mixed for individuals with BN. Medina-Pradas and colleagues [57] observed that BN participants exhibited poorer performance than HCs when identifying positive emotions in the eyes, though these results have not been replicated in later studies [56, 58].

In conclusion, this updated review of the literature suggests that there is consistent evidence that individuals with AN and BN do not differ from HCs in their ability to identify positive emotions in the faces of others. This aspect of emotion

**Table 1** Basic emotion recognition tasks reported in eating disorder participants

Study	Number of samples	Measure/emotion	Findings for positive emotions	Findings for negative emotions
Zonnevylle-Bender et al. (2002) [36]				
ED	30	Emotion recognition task (pictures taken from JACFEE)	In general, ED participants showed worse performance recognising emotions from faces	In general, ED participants showed worse performance recognising emotions from faces
HC	33	Happiness, surprise Anger, contempt, disgust, fear, sadness	Only overall results provided, no details about specific emotions	Only overall results provided, no details about specific emotions
Zonnevylle-Bender et al. (2004) [37]				
AN adolescents	48	Emotion recognition task (pictures taken from JACFEE)	In general, no group difference in accuracy recognising emotions from faces	In general, no group difference in accuracy recognising emotions from faces
Mixed psychiatric controls	48			
HC	48	Happiness, surprise Anger, contempt, disgust, fear, sadness	Only overall results provided, no details about specific emotions	Only overall results provided, no details about specific emotions
Kucharska-Pietura et al. (2004) [39]				
AN	30	Emotion recognition experiment	No significant difference in accuracy recognising positive facial emotions	AN showed poorer performance recognising negative facial emotions, particularly for sadness and fear
HC	30	Happiness, interest, surprise Anger, contempt, disgust, fear, sadness, shame		
Mendlewicz et al. (2005) [40]				
AN	36	Emotion facial expressions task	No significant difference in accuracy recognising positive facial emotions	No significant difference between AN and HC in accuracy recognising negative facial emotions
Depression	21	Happiness		Depressed group showed lower accuracy recognising angry faces presented with 70 % of intensity
HC	32	Anger, disgust, fear, sadness		
Kessler et al. (2006) [41]				
AN	48	Facially expressed emotion recognition (pictures taken from JACFEE)	No significant difference in accuracy recognising happy faces	No significant difference in accuracy recognising negative emotions in faces
BN	31	Happiness, surprise	AN and BN showed worse performance recognising surprise, but the absolute difference was very small	
HC	78	Anger, disgust, fear, sadness		
Pollatos et al. (2008) [42]				
AN	12	Karolinska Directed Emotional Faces	Happy faces (along with angry faces) were better recognised than other emotions by all the participants (AN and HC)	Angry faces (along with happy faces) were better recognised than other emotions by all the participants (AN and HC)
HC	12	Happiness Anger, disgust, fear, sad Neutral	No significant group difference in the accuracy recognising happy faces	AN showed worse performance than HC recognising neutral, sad, and disgusted faces
Jansch et al. (2009) [38]				
AN	28	Facial expression recognition task (pictures taken from PoFa)	Overall, AN showed worse performance than HC recognising positive and negative emotions	Overall, AN showed worse performance than HC recognising positive and negative emotions
HC	28	Happiness, surprise Anger, disgust, fear, sadness	No particular emotion was identified more accurately in either group	No particular emotion was identified more accurately in either group

**Table 1** (continued)

Study	Number of samples	Measure/emotion	Findings for positive emotions	Findings for negative emotions
Castro et al. (2010) [43]				
AN	30	Facial Affect Recognition Task	AN diagnosis was not associated with discrimination accuracy of happy faces	Discrimination accuracy of sad faces presented for 500 ms was associated with AN
HC	40	Happiness Sadness Neutral	Obsessionality was associated with discrimination accuracy of happy faces presented for 2000 ms, but did not remain significant after multiple testing correction	diagnosis, BMI, obsessionality and ED symptomatology In the multiple regression model, the only significant predictor was obsessionality Discrimination accuracy of sad faces presented for 2000 ms was associated with AN diagnosis, but it was no longer significant after correcting for multiple testing
Kühnpast et al. (2012) [44]				
BN	16	Karolinska Directed emotional faces	Happy faces were better recognised than the other emotions by all participants (BN and HC)	BN showed poorer performance recognising angry faces, misclassifying them as fearful or neutral
HC	13	Happiness Anger, fear Neutral	No significant group difference in the accuracy recognising happy faces	

Peer reviewed articles in English were included in this table

AN anorexia nervosa, BN bulimia nervosa, ED eating disorder, HC healthy control, JACFEE Japanese and Caucasian facial expressions of emotion, PoFa Pictures of Affect, BMI body mass index

**Table 2** Reading the Mind in the Eyes task reported in eating disorder population

Study	Number of samples	Measure/emotion	Findings for positive states	Findings for negative states
Russell et al. (2009) [46]				
AN	22	Reading the Mind in the Eyes	Only overall performance reported. AN were less accurate than HC	Only overall performance reported. AN were less accurate than HC
HC	22			
Harrison et al. (2009) [47]				
AN	20	Reading the Mind in the Eyes	Only overall performance reported. AN showed fewer correct answers than HC	Only overall performance reported. AN showed fewer correct answers than HC
HC	20			
Harrison et al. (2010) [48]				
AN	50	Reading the Mind in the Eyes	Only overall performance reported. ED (AN and BN together) showed fewer correct answers than HC. AN scored fewer correct answers than BN	Only overall performance reported. ED (AN and BN together) showed fewer correct answers than HC. AN scored fewer correct answers than BN
BN	50			
HC	90			
Oldershaw et al. (2010) [55]				
AN	40	Reading the Mind in the Eyes	Current AN performed significantly worse than HC	Group differences approached significance. AN and recovered AN performed similarly, showing fewer correct answers than HC. But differences were not significant
Recovered AN	22			
HC	47			
Harrison et al. (2010) [49]				
AN	50	Reading the Mind in the Eyes	Only overall performance reported. Both, AN and recovered AN, performed similarly, showing fewer correct answers than HC	Only overall performance reported. Both, AN and recovered AN, performed similarly, showing fewer correct answers than HC
Recovered AN	35			
HC	90			
Medina-Pradas et al. (2012) [57]				
AN	44	Reading the Mind in the Eyes	AN performed similar to HC	No difference between HC and clinical groups
BN	30		BN showed lower score than HC	
EDNOS	23		Trend for EDNOS to show poorer scores than HC	
HC	39			
Adenzato et al. (2012) [50]				
AN	30	Reading the Mind in the Eyes	Only overall performance reported. No differences between AN and HC	Only overall performance reported. No differences between AN and HC
HC	32			
Kenyon et al. (2012) [58]				
BN	48	Reading the Mind in the Eyes	No differences between groups	No differences between groups
EDNOS	34			
HC	57			
Goddard et al. (2013) [51]				
ED offspring	65	Reading the Mind in the Eyes	Only overall performance reported. No differences between ED offspring and HC offspring	Only overall performance reported. No differences between ED offspring and HC offspring
HC offspring	50			
ED mothers	70			
HC mothers	50			
ED fathers	54			



**Table 2** (continued)

Study	Number of samples	Measure/emotion	Findings for positive states	Findings for negative states
HC fathers	51			
Tapajoz et al. (2013) [52]				
AN	24	Reading the Mind in the Eyes	Only overall performance reported. AN were less accurate than HC and BN groups	Only overall performance reported. AN were less accurate than HC and BN groups
BN	24			
HC	24			
Kanakam et al. (2013) [53]				
ED twins	51	Reading the Mind in the Eyes	Only overall performance reported. ED twins were less accurate than control twins at a trend level. The impairment was more pronounced in AN twins than BN	Only overall performance reported. ED twins were less accurate than control twins at a trend level. The impairment was more pronounced in AN twins than BN
Unaffected co-twins	19			
Control twins	42		Unaffected co-twins were less accurate than control twins at a trend level	Unaffected co-twins were less accurate than control twins at a trend level
Tapajoz et al. (2013) [56]				
AN	22	Reading the Mind in the Eyes	No difference between HC and clinical groups	AN performed significantly worse than BN and HC. BN performance was similar to HC
BN	19			
HC	24			
Goddard et al. (2014) [54]				
ED (males)	28	Reading the Mind in the Eyes	Only overall performance reported. No difference between ED and HC	Only overall performance reported. No difference between ED and HC
HC (males)	41			

Peer reviewed articles in English were included in this table

*N* sample size, *AN* anorexia nervosa, *BN* bulimia nervosa, *ED* eating disorder, *HC* healthy control

processing could represent a strength for people with EDs. However, it is unclear whether this ability is reduced when it comes to more complex positive emotions, such as those assessed by the RME task. A limitation that should be taken into account when interpreting these results is that all the studies evaluating basic emotional recognition assessed only one positive emotion: happiness. This is of relevance because as previously mentioned, Fredrikson's [10, 13] research highlights the existence of 10 positive emotions and research has shown that the main sign of happiness, the smile, is very easy to recognise. In two studies, one with AN participants and another with BN participants, happiness was associated with the highest recognition rate—around 99 %—in both the clinical and the non-clinical sample [42, 44]. Moreover, there is evidence that the accuracy in identifying happy faces tends to be very high—over 90 %—in several cultures, including Western cultures [59]. Therefore, given that most studies have used faces showing prototypical expressions of emotions, it is reasonable to suggest that a ceiling effect may be occurring here. Future studies should attempt to overcome this limitation by using more complex stimuli such as blended emotions, using other means of expressing happiness such as the tone of voice or body language, and assessing recognition of other positive emotions such as joy, gratitude, pride, awe or love [10].

Another limitation of the current literature is that it is mainly based on studies on female participants. Only one study explored emotion recognition in males with eating disorders using the RME task and found no differences among males with AN, BN and HCs [54]. This study looked at the ability to recognise emotions in general and did not report results for positive and negative emotional states separately, so it is not known whether the ability to identify positive emotional states of males with EDs differs from HCs. Investigating emotion recognition in males with EDs is relevant, because there is evidence of gender differences in emotion recognition in the general population, with females being more accurate than men at recognising basic facial emotions [60, 61].

### Neural Correlates of Positive Emotions in EDs

To our knowledge, only two studies have explored neural correlates of emotional processing in people with EDs. In the first one, Friederich and colleagues [62] explored the startle reflex paradigm using positive and negative stimuli selected from the International Affective Picture System [63]. Generally, they found that a strong startle reflex was associated with fear and disgust. As expected, HCs had a strong startle response to negative images, a less pronounced

response to neutral images and a very weak response to positive images, suggesting that the images had a differing effect on the participants. Interestingly, in both clinical groups (AN and BN), the participants exhibited a strong startle response to both positive and negative images and a less strong response to neutral stimuli, suggesting that patients and non-ED participants had different biological responses to emotions.

In the second study, Fonville and colleagues [64•] used an implicit emotion task [65] with neutral and positive faces to examine brain activation using fMRI. This paradigm allowed us to explore how people with and without AN responded to neutral, 50 % happy and 100 % happy faces, whilst completing a gender discrimination task. Comparing 31 AN and 31 HC participants, Fonville [64•] found that the presentation of 100 % happy faces was associated with significantly increased blood flow in the right fusiform gyrus and occipital lobes in AN participants, compared to HCs. These data provide preliminary evidence of a different biological response to positive emotion when positive stimuli are perceived, whether in the form of a positive image or a happy face.

### Expression of Positive Emotions in People With EDs

Another area of emotional processing that has received interest is the study of emotion expression in people with EDs. Although there has been little experimental investigation in this area, findings from Davies [66•, 67] suggest that people with AN express positive and negative emotions differently to HCs. Specifically, when asked to describe their emotional experience, people with AN used fewer words and, more importantly, fewer positive affect words than HCs [68]. A further study carried out by the same investigators explored coded facial emotional expression in response to video clips depicting different emotional valences, in people with current AN, individuals who had recovered from AN (RecAN) and HCs [67]. In response to an amusing clip, AN participants showed significantly less positive emotional expression (e.g. smiling) than both HC and RecAN groups, and both AN and RecAN groups showed more negative expression than HC participants. In response to a sad clip, there was no difference between the groups in terms of positive expression, but AN participants showed significantly less negative expression than HCs [67]. These results echo findings from self-report studies where it has been shown that people with EDs inhibit their expression of emotions [e.g. 69], and it has been proposed that these difficulties may contribute to the maintenance of the illness, inhibiting recovery [8]. A similar pattern of findings has been observed in adolescent ED patients [70]. In addition, emotion expression has been studied in participants with BN, but results for this population are less clear.

For example, Davies' study on verbal emotion expression [68] did not find significant differences between participants with BN and HCs. In contrast, Tarrega and colleagues [71] studied the facial expression of joy and anger in response to a therapeutic video game and found differences among individuals with current BN, people who had recovered from BN (RecBN) and HC participants. Whilst playing the game, participants with BN exhibited facial expressions of joy for longer time than HCs and expressed anger for less time than HCs. The RecBN group exhibited an intermediate pattern. These results could be interpreted as evidence of intact ability to express positive emotions in BN, which could be a strength to be used in treatment. However, Tarrega's video game was not aimed at eliciting positive emotions, and their BN participants described themselves as more anxious than HCs, which led to the authors' suggestion that the increased facial expression of joy might not be an authentic response and could be related to a desire to gain acceptance and avoid rejection [71]. More studies are needed to further characterise the expression of positive emotions in people with BN and its possible role in the ED pathology.

In general, a smile is a very powerful social signal that has been associated with positive intentions [72] and increased sociability [73]. Lack of expression, on the other hand, is a strong signal of disinterest or rejection of the opportunity to make contact. The reduced facial expression of positive emotions in AN participants might be related to their higher levels of social anhedonia, a failure to seek out and experience reward from social interaction [2, 3, 74]. Furthermore, there is some evidence that making friends and maintaining a social network is highly problematic for people with an ED even before the onset of illness [4]. It might be that since people with AN gain less pleasure from social communication, they are less interested in attracting social interactions, and the reduced facial positive expression serves the purpose to avoid social interaction. On the other hand, it might be the case that since people with AN exhibit less positive facial expressions, they are less likely to participate in positive social interactions, and therefore, they are less exposed and obtain less pleasure out of the experience. In any case, it would be important to support these patients to build their social skills to help them flourish. Assisting patients with AN to facially express more positive emotions, particularly to smile more often, along with techniques aimed at increasing their experience of positive emotions, such as those described by Lyubomirsky and Layous [18], might have a positive impact in their social life. This is relevant because patients with AN tend to isolate themselves and to report a high impact of the illness on social leisure and relationships [1]. Improving patients' social life will benefit their overall quality of life and might facilitate the process of recovery.

## Future Directions

More empirical studies, particularly experimental studies, exploring emotional processing and expression in people experiencing EDs are needed to provide clinically relevant data to inform and refine existing prevention and treatment methods. In particular, our review has highlighted that very few experimental studies have actually delineated and reported data regarding whether people with EDs process positive and negative emotions differently to HCs. It would be helpful for future studies to include such analyses involving the effect of emotional valence in order to establish a more comprehensive and representative understanding of these phenomena.

Further research is also required to explore the range of positive emotions in people with an ED. No studies have directly explored ED patients' subjective experience of a broad range of positive emotions. Both experimental and qualitative ideographic methodologies would be helpful in furthering this line of research.

In future clinical research, it may be helpful to explicitly pilot and evaluate the use of therapeutic interventions derived from positive psychology in the treatment of people with EDs (e.g. 'three good things', how to elicit simple pleasures, behavioural activation toolbox, gratitude letters, etc.). If people with EDs do struggle to identify their own and other people's emotions and have difficulty expressing positive emotion, then it is plausible that therapeutic approaches incorporating an emphasis on increasing positive emotions and positive communication, developing personal strengths, finding direction and meaning and engaging in the present moment may prove helpful in improving well-being and promoting the recovery of people with EDs.

Duckworth and colleagues [9] point out that positive psychology emphasises not only the study of positive emotion, personal strengths and skills of the individual but also that of positive institutions. These are institutions that allow the experience and expression of positive emotions, such as the family, school/work and the community, to enhance mental health and promote wellness. From this perspective, it is clear that *positive institutions* such as the family, schools and the workplace could be utilised to develop personal strengths and resilience in order to protect against the development of EDs. It is well established that institutions such as the media (e.g. via promotion of the 'thin ideal'), peer group and patterns of family communication can all act as risk factors for the development of EDs [75, 76]. However, it is also possible that these institutions might hold the power to exert a positive influence on well-being and protect against the development of EDs (e.g. via ED prevention programmes in schools promoting a healthy body image and critical media consumption and family-based interventions focusing on personal strengths). Indeed, there is evidence that eating disorder prevention

programmes can produce small to moderate effects on reducing maladaptive eating attitudes and behaviours [e.g. 24]. These are also important areas for future research to explore.

## Conclusion

This paper has reviewed the experimental research on emotions in people with EDs, generated by our research group and others in the field. It has also explored the application of a positive psychology framework, in particular, the study and application of positive emotions for supporting recovery from an ED. The review highlights that there are few studies addressing these areas, despite the evident potential benefits of this approach in the prevention and treatment of EDs.

The domain which has received greater interest is the perception of emotions. This review shows that there is consistent evidence that people with EDs are able to recognise simple positive emotions (i.e. happiness) in other people's faces, but it is less clear whether or not they have similar abilities when it comes to more complex positive states, as exhibited by results from the Reading the Mind in the Eyes task. Furthermore, recent studies have attempted to determine whether people with EDs show different brain processes when performing emotional tasks, providing preliminary evidence of different neurological responses to positive emotional stimuli. In the field of emotion expression, our review suggests that people with AN use fewer words to describe emotional experiences and exhibit reduced facial expression of emotions, compared to HCs.

Taking all of these findings into account, this review proposes that the study of positive psychology, in particular the study of positive emotions, would enrich our understanding of eating pathology and provide new tools that might have a positive impact on prevention, treatment and in improving quality of life. Given these potential clinical implications, this review represents a call for more research in these areas.

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## Compliance with Ethics Guidelines

**Conflict of Interest** Kate Tchanturia, Marcela A. Marin Dapelo, Amy Harrison, and David Hambrook declare that they have no conflict of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

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Since the publishing of this article, two new studies investigating emotion recognition and expression have emerged. These studies are briefly described below, along with a study on emotion recognition from body movement that was not included in the article.

Lule et al. (2014) studied emotion recognition in adolescent females with AN and HC, using the facially expressed emotion labelling test (FEEST). The results of the study indicated that participants with AN were better than HC at recognising happiness, but worse at identifying disgust. There were no differences between the groups on anger, fear, and surprise recognition.

Cardi et al. (2015) investigated emotion recognition and expression in women with ED (AN or BN) and HC. Four videos depicting one adult displaying happiness, sadness, anger, or a neutral emotion expression were used. Emotion recognition was assessed asking participants to rate the clips according to valence (i.e. positive for happy video, and negative for sad, and angry video) and intensity of emotion displayed using the Emotional Assessment Scale. Emotion expression was measured recording participant's facial expressions whilst watching the videos, and coding it using the Facial Expression Coding System (FACES). Results indicated that people with ED did not differ from HC in emotion recognition, but exhibited fewer facial expressions than HC. Specifically, participants with ED showed fewer positive facial expressions in response to the happy video, and fewer negative expressions in response to the sad and angry video.

Zucker et al. (2013) explored the ability to recognise emotions from body movements in individuals with AN and HC using point light walkers. The study finding showed that participants with AN were less accurate than HC identifying sadness, and more consistent in recognising anger (Zucker et al., 2013).

These studies support the conclusion of the article, further evidencing that (a) people with ED do not have difficulties recognising happiness, (b) the evidence for difficulties in emotion recognition of negative emotions is mixed, and (c) people with ED show a reduced facial expression of emotions.



### 1. 3. THE CURRENT THESIS

The literature reviewed in the previous sections provided a relevant background that informed the research questions and design of this thesis. The maintenance models of ED highlighted the relevance of emotional difficulties in AN and BN, and inspired the idea of studying emotion recognition and expression in ED. On the other hand, the basic emotion perspective stressed the need to investigate discrete emotions separately, rather than using a global outcome that combines all emotions or groups of emotions (e.g., positive and negative emotions), as in some previous studies<sup>1</sup>. Ekman's theory was chosen as a main theoretical framework for this thesis, because of the large amount of evidence supporting its claims, and because it provides a clear and validated methodology to assess emotion expressions.

The review of the evidence on basic emotion recognition suggested that people with ED are able to recognise happiness, but the evidence for recognition of negative emotions is less conclusive, and warranted further exploration. Moreover, previous studies have investigated emotion recognition using prototypical facial expressions of emotions, but recent developments of basic emotion theory indicate that in real life, people rarely express a single emotion, questioning the ecological validity of the previous studies. Taking all the above into consideration, this thesis aims to investigate the ability to recognise emotions in blended expressions in ED.

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<sup>1</sup> The studies included in this thesis examine discrete emotions with one exception. Study 4.3 ('Deliberately generated and imitated facial expressions of emotions in people with eating disorders') utilises an overall outcome combining all emotions. The rationale for doing this is that (1) this is an exploratory study, the first one investigating posed and imitation of facial expressions in ED, and (2) there were concerns about the study being underpowered to conduct separate analysis for each basic emotion.

Emotional responses involve body postures and body movements. Thus, this thesis assesses emotion recognition in body movements, an area that has been less investigated in both basic literature on emotions and the ED literature.

The thesis also focuses on emotion expression. It builds upon the previous research on spontaneous facial expression of emotions in ED, but rather than focusing on overall dimensions of positive and negative emotions, specific facial expressions of basic emotions are assessed. In addition, based on Ekman's work regarding the importance of the Duchenne smile as an expression of real happiness, a study is dedicated to investigate this facial expression in people with ED.

The work of Fridlund (1994) provided insights about the social function of facial expressions. Given that spontaneous facial expressions are deemed to be less suitable for studying intentional facial expressions, this thesis explores posed facial expressions of emotions for the first time in people with ED.

Finally, this thesis explores imitation of facial expressions of emotions in ED. The rationale for studying imitation comes from the emotion literature proposing that imitation is a key mechanism in learning to control one's facial expression. This is the first study investigating imitation of emotional facial expressions in ED.

### **1.3.1. Aims**

The overall aim of this thesis is to investigate difficulties in emotion recognition and expression in women with AN and BN, compared to healthy controls.

It was hypothesized that participants with ED will be less accurate recognising emotions and will be less facially expressive than HC. Participants with AN will exhibit more difficulties than participants with BN. Specific hypotheses are detailed on each study.

#### *1.3.1.1. Specific aims:*

Aim 1. To investigate emotion recognition in blended facial expressions of emotions in people with ED.

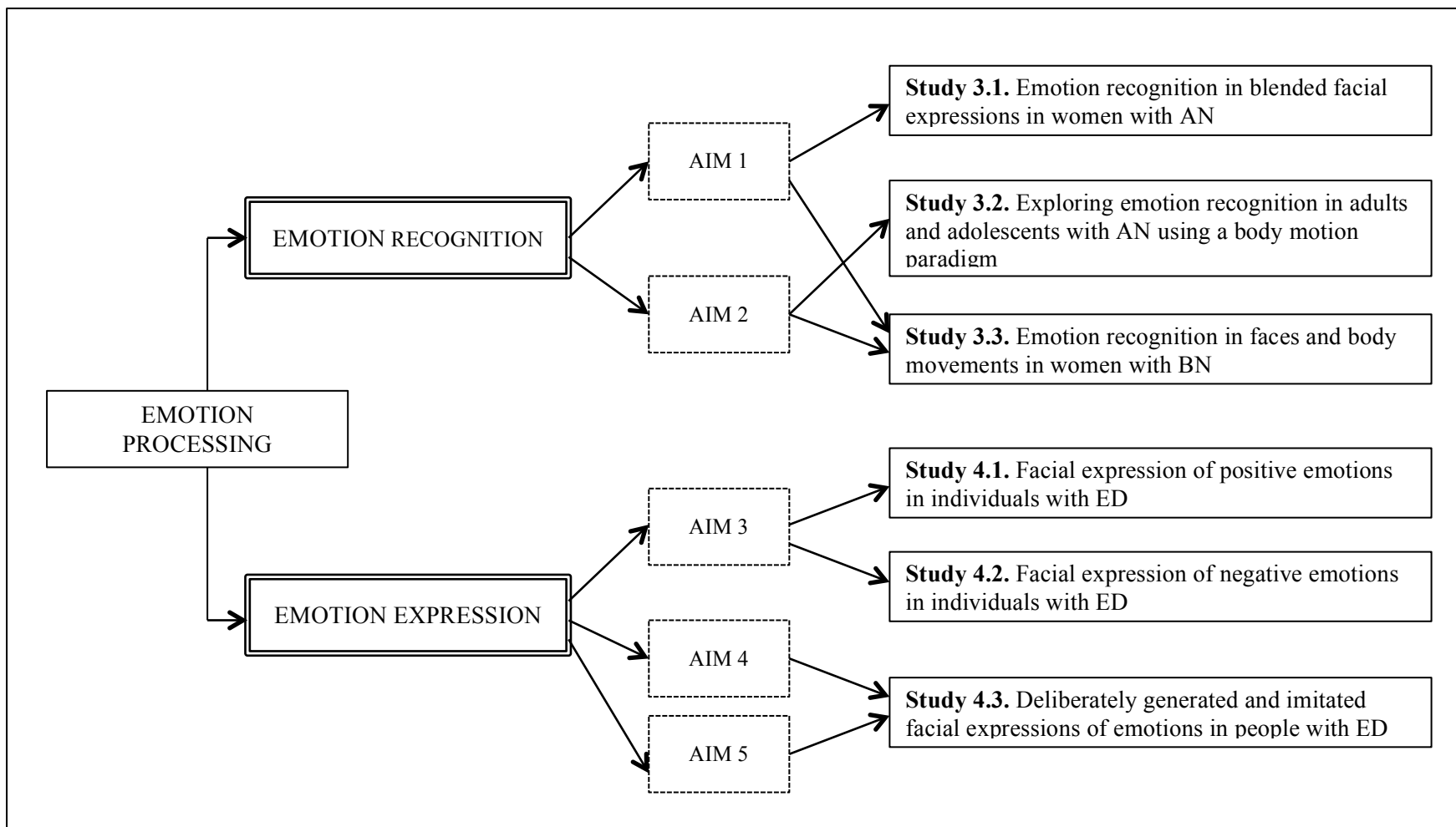
Aim 2. To evaluate emotion recognition from body movements in people with ED.

Aim 3. To assess spontaneous facial expression of emotions in people with ED.

Aim 4. To explore posed facial expression of emotions in people with ED.

Aim 5. To explore imitation of facial expressions of emotion in people with ED.

**Figure 1.6. Thesis map**



Note: All studies were conducted in female participants; however, some of the titles refer to “people” or “individuals” without the gender specification.

## CHAPTER 2

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### GENERAL METHODS

## **OVERVIEW**

This chapter aims to offer a general overview of the methodology employed in the thesis. In addition, it provides more detailed information about some aspects of the methods, such as experimental tasks and coding systems, thereby complementing the articles presented in chapters 3 and 4.

Each study's specific methodology can be found within each of the study articles or sections.

## **GENERAL METHODS**

### **2.1. DESIGN**

All the empirical studies included in the thesis have a cross-sectional, case-control design using experimental measures.

### **2.2. PARTICIPANTS**

#### **2.2.1. Inclusion and exclusion criteria**

Three groups of participants were included: people with AN, with BN, and HC. All participants were female, between the ages of 18 and 55 years old. The inclusion and exclusion criteria for all studies are shown in table 2.1 and table 2.2.

The only exception is study 3.2, which was conducted jointly with Ms Katie Lang, and included adolescents in addition to adults. In this case, the inclusion criteria included a more expanded age range (11 to 55 years old). Weight thresholds for the children samples were a percentage ideal body weight (%IBW) less than 90 for the AN group, and above 90 for the HC group.

Even though the design of this thesis started before the introduction of DSM-5 (APA, 2013), a preliminary version of the new diagnostic criteria for AN and BN had been published on the American Psychiatric Association website on 2010. Thus, the main changes in diagnosis (i.e., removal of amenorrhea in AN and reduction of bingeing and purging episodes in BN) were known to the candidate and were considered when defining the inclusion and exclusion criteria for all studies.

**Table 2.1. Inclusion criteria**

<b>Anorexia Nervosa</b>	<b>Bulimia Nervosa</b>	<b>Healthy Control</b>
Female	Female	Female
Age between 18 and 55 years	Age between 18 and 55 years	Age between 18 and 55 years
Fluent in English language	Fluent in English language	Fluent in English language
Meets DSM-IV criteria for AN, with the exclusion of criterion D (amenorrhea)	Meets DSM-IV criteria for BN, with a frequency of binge eating/purging behaviour of at least once a week.	
BMI below 18.5 kg/m <sup>2</sup>	BMI above or equal to 18.5 kg/m <sup>2</sup>	BMI above or equal to 18.5 kg/m <sup>2</sup> , but below 30 kg/m <sup>2</sup>

**Table 2.2. Exclusion criteria**

<b>Anorexia Nervosa</b>	<b>Bulimia Nervosa</b>	<b>Healthy Control</b>
Diagnosis of autism spectrum disorder or psychotic disorder	Diagnosis of autism spectrum disorder or psychotic disorder	Current or past diagnosis of AN, BN, or Binge Eating Disorder
Brain injury	Brain injury	Diagnosis of autism spectrum disorder or psychotic disorder
Inability to provide informed consent	Inability to provide informed consent	Meets clinical cut-off points on depression or anxiety scales
		Brain injury
		Inability to provide informed consent



ED diagnosis was determined using the Structured Clinical Interview for DSM-IV (First, Gibbon, Spitzer, & Williams, 2002), along with measures of height and weight taken on the day of the assessment. Psychopathology was assessed using self-report measures, such as the HADS, and AQ-10.

The groups and number of participants varied between studies and is provided for each individual study in its specific section.

### **2.2.2. Recruitment**

Participants with ED were recruited from ED specialist clinical services within the South London and Maudsley NHS Foundation Trust and Central and North West London NHS Foundation Trust and through advertisement in the Beat charity website and circular ([www.b-eat.co.uk](http://www.b-eat.co.uk)). HC participants were recruited through university circulars, and public adverts in the areas surrounding the university.

## **2.3. ETHICAL APPROVAL AND CONSENT**

Ethical approval for the studies included in the thesis was granted by the Nottingham NHS Research Ethics Committee, West London (ref. 13/LO/0201). Written informed consent was obtained from all participants. Ethical approval letter and information sheet can be seen in the appendices section.

Study 3.2 was conducted jointly with Ms Katie Lang, and therefore has an additional ethics approval (ref. 12/LO/2015). In the case of this study, both child and parental consent was obtained for participants aged below 17.

## **2.4. MEASURES**

### **2.4.1. Body mass index (BMI in Kg/m<sup>2</sup>)**

BMI was calculated from measures of height and weight obtained on the day of the assessment.

### **2.4.2. Clinical Interview**

*2.4.2.1. Structured Clinical Interview for DSM-IV-TR Axis I Disorders; SCID (First et al., 2002):* The SCID is a semi-structured clinical interview used to assess axis I disorders according to the DSM-IV (APA, 2000). The ED module (module H) was used to assess current and past diagnosis of ED. In order to adjust the interview to DSM-5 criteria (APA, 2013), amenorrhea was not required for AN diagnosis, and the frequency of binge eating and purging behaviour was reduced to once a week for the diagnosis of BN.

### **2.4.2. Self-report measures**

*2.4.2.1. Demographics:* A demographic questionnaire with questions on age, education, psychiatric and physical health conditions, and current medication/ treatment.

*2.4.2.2. Eating Disorder Examination Questionnaire; EDE-Q (Fairburn & Beglin, 1994):* The EDE-Q is a 36-item self-report measure that assesses cognitive and behavioural features of ED. It has four subscales (i.e., dietary restraint, eating concern, shape concern and weight concern) and a global score that ranges from 0 to 6. The questionnaire has been widely used in the ED field, and has shown good psychometric properties (Fairburn & Beglin, 1994).

*2.4.2.3. Hospital Anxiety and Depression Scale; HADS (Zigmond & Snaith, 1983):* The HADS is a 14-item 2-subscale questionnaire developed to assess anxiety and depression

(HADS-A and HADS-D, respectively). An advantage of the HADS over other measures is that it excludes somatic symptoms that are usually present in ED, such as dizziness, focusing more on the psychological features of anxiety and depression (Zigmond & Snaith, 1983). Each subscale score ranges from 0 to 21, and a cut-off point of 10 has been suggested for the identification of clinically significant anxiety or depression. HADS scores have shown to correlate with other measures of anxiety and depression, such as the State and Trait Anxiety Inventory, and the Beck Depression Inventory (Zigmond & Snaith, 1983), and to have adequate validity and reliability (Bjelland, Dahl, Haug, & Neckelmann, 2002).

*2.4.2.4. Autism Quotient; AQ-10 (Allison, Auyeung, & Baron-Cohen, 2012):* The AQ-10 is a shorter version of the Autism Quotient (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001), which is widely used to assess autistic features, and has good psychometric properties (Allison et al., 2012). The AQ-10 score ranges from 1 to 10, and a cut-off of 6 has been established to indicate clinical severity of autistic features.

*2.4.2.5. Obsessive-Compulsive Inventory Revised; OCI-R (Foa et al., 2002):* The OCI-R is an 18-item self-report questionnaire, scored on a 5-point Likert scale. It has 6 subscales: washing, checking, ordering, obsessing, hoarding, and mental neutralizing. The total score ranges from 0 to 72, with a total score above 21 suggesting the presence of clinically relevant obsessive symptoms. The OCI-R has shown good internal consistency, convergent validity, and test-retest reliability (Foa et al., 2002).

*2.4.2.6. Toronto Alexithymia Scale; TAS-20 (Bagby, Parker, & Taylor, 1994):* The TAS-20 is 20-item, self-report questionnaire aimed to evaluate alexithymia. It comprises 3 subscales: difficulty identifying feelings, difficulty describing feelings, and externally oriented thinking. The overall score ranges from 0 to 100, with a cut-off score of above

60 indicating high alexithymia. The TAS-20 has been widely used, and has shown to be a reliable and valid measure (Bagby, Taylor, & Parker, 1994; Parker, Taylor, & Bagby, 2003).

*2.4.2.7. Positive and Negative Affect Scale; PANAS (Watson, Clark, & Tellegen, 1988):*

The PANAS is a 2-subscale scale developed to assess positive and negative affect. Each subscale has 10 descriptors (for positive affect: attentive, interested, alert, excited, enthusiastic, inspired, proud, determined, strong, and active; for negative affect: distressed, upset, hostile, irritable, scared, afraid, ashamed, guilty, nervous, and jittery), and participants are asked to rate on a 5-point scale the extent to which they have experienced each mood state during a specified time frame. Each subscale score ranges between 10 and 50. The scale has exhibited good psychometric properties, and has shown to be sensitive to fluctuations in mood when used with short-term instructions (e.g. right now, or today) (Watson et al., 1988).

The number of self-report measures used varied depending on the study. For each study sample, the internal consistency for self-report measures was assessed using Cronbach's alpha coefficient. This information is reported on each study section.

All self-report measures can be found in the appendices section.

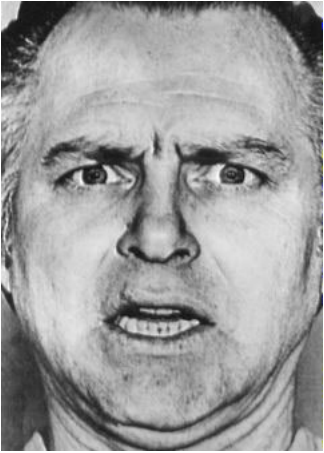
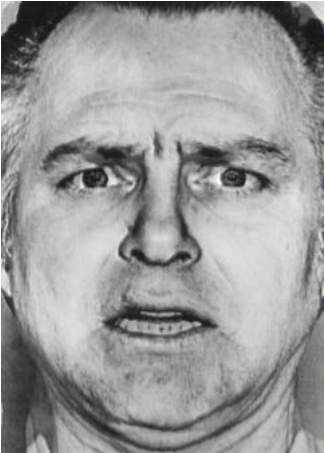


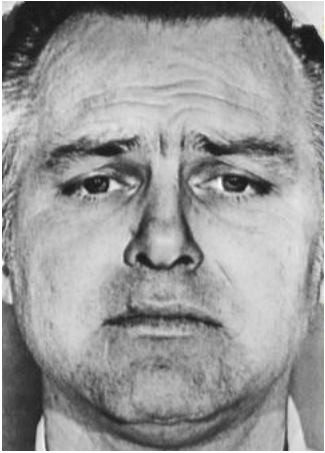
### 2.4.3. Experimental measures

#### 2.4.3.1. Facial emotion recognition task: *Facial Expressions of Emotion: Stimuli and Test (FEEST; Young, Perret, Calder, Sprengelmeyer, & Ekman, 2002; Young et al., 1997)*

Study 3.1 and 3.3 used a facial emotion recognition task in which images of facial expressions are shown in a computer screen and participants select the emotion that best describes the facial expression shown. The stimuli were taken from the FEEST set of morphed facial expressions (Young et al., 2002; Young et al., 1997). This set contains black and white images of facial expressions of blended emotions, and it was developed by morphing prototypical expressions of happiness, fear, sadness, disgust and anger, into pairwise combinations (Young et al., 1997). Five morphed images were created using the following proportions: 90:10 (e.g., 90% anger 10% sadness), 70:30 (e.g., 70% anger, 30% sadness), 50:50 (e.g., 50% anger, 50% sadness), 30:70 (e.g., 30% anger, 70% sadness), and 10:90 (e.g., 10% anger, 90% sadness) (Table 2.3).

Studies 3.1 and 3.3 used ten emotion blends (i.e., happiness-fear, happiness-sadness, happiness-disgust, happiness-anger, fear-sadness, fear-disgust, fear-anger, sadness-disgust, sadness-anger, and disgust- anger) with five images using the different proportions (i.e., 90:10, 70:30, 50:50, 30:70, and 10:90) per combination, providing a total of 50 images. Male and female faces were used, thus the total was doubled to 100 images (10 combinations types X 5 proportions X 2 genders).

Table 2.3. Example of FEEST stimuli: Images for anger and sadness blend

				
90% Anger 10% Sadness	70% Anger 30% Sadness	50% Anger 50% Sadness	30% Anger 70% Sadness	30% Anger 70% Sadness

Source: Young et al. (2002)

The 100 images were randomized and presented on a grey background on a computer screen, along with five answer choices (afraid, angry, disgusted, happy, or sad). Participants had to select the answer choice that best described the facial expression, in a forced-choice paradigm. The images were presented three times, in different order, with a five-minute rest interval between each block of faces. There was no time limit. The task took approximately 30 minutes to complete.

The reliability and validity of the FEEST stimuli has been established in previous studies with healthy individuals (Young et al., 2002; Young et al., 1997). Moreover, even though the set of images shows a continuum of blended expression, there is evidence that people identify each facial expression as a discrete emotion (e.g. labelling as ‘anger’ an expression showing 70% anger and 30% sadness) (Young et al., 1997). Therefore, FEEST is a validated set of facial expressions that can be used to investigate emotion recognition. In addition, by using facial expressions of blended emotions, which are more common in reality than prototypical expressions of emotions (Buisine et al., 2006; Ekman & Cordaro, 2011), FEEST is more ecologically valid than other sets of facial expressions.

FEEST has been used in studies of facial emotion recognition in people with ASD (Humphreys, Minshew, Leonard, & Behrmann, 2007), obsessive-compulsive disorder (Jhung et al., 2010), and borderline personality disorder (Domes et al., 2008). But before this thesis, it had not been used in participants with ED.

#### 2.4.3.1.1. Scoring system

In studies 3.1 and 3.3 the facial emotion recognition task was scored using two outcomes, one for recognition accuracy and one for response bias.

Recognition accuracy was evaluated through the percentage of correct responses. This was obtained for each emotion at 90% (i.e., 90:10) and 70% (i.e., 70:30) proportion. For

example, in order to calculate the results for anger at 90%, the percentage time the participant selected 'anger' for all faces containing anger at 90% was recorded (i.e., for the faces in which anger was mixed with either 10% disgust, fear, happiness or sadness) (Humphreys et al., 2007). Given that in the images showing emotions at 50% proportion (i.e., 50:50) there are two 'correct' responses, the percentage of responses for both 'correct' answers was considered. For example, in a picture depicting 50% anger and 50% disgust, both emotions were considered 'correct' (Humphreys et al., 2007).

In order to obtain response bias scores, the percentage time a participant selected an 'incorrect' response was calculated. For example, in order to calculate the scores for response bias towards anger at 90% the percentage of 'anger' response to all 90% proportion stimuli that did not contain anger was recorded (Isaacowitz et al., 2007).

*2.4.3.2. Body motion emotion recognition task: Point light walkers (PLW; Atkinson, Heberlein, & Adolphs, 2007; Heberlein, Adolphs, Tranel, & Damasio, 2004; Johansson, 1973)*

Study 3.2 and 3.3 use PLW to evaluate emotion recognition in body movement. This method was created by Johansson (1973) to evaluate body motion. It was then adapted to explore the ability to infer emotional states expressed through body movements (Heberlein, Adolphs, Tranel, & Damasio, 2004).

For the development of PLW, actors were filmed walking from left to right, whilst portraying one of four emotions (anger, fear, happiness, or sadness) or an emotionally neutral state. The actors were filmed in the dark and had small lights attached to their wrists, ankles, knees, elbows, outer hips, waist, outer shoulders and head. Thus, the stimuli appeared as white dots on a dark background (Atkinson et al., 2004). The emotional content of the clips was often quite exaggerated and involved, for example, the actor repeatedly stamping his foot on the floor and shaking his arms showing rage. For the neutral clips, the walker expressed no obvious emotion and generally just walked



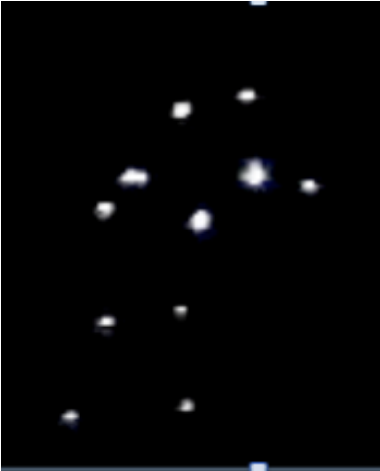


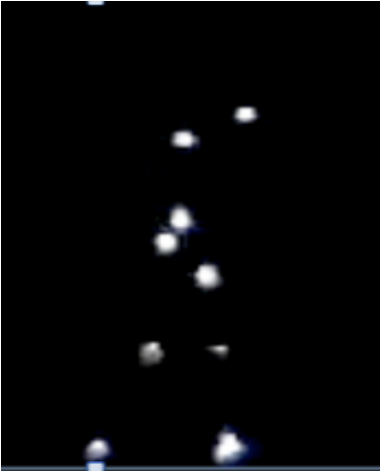
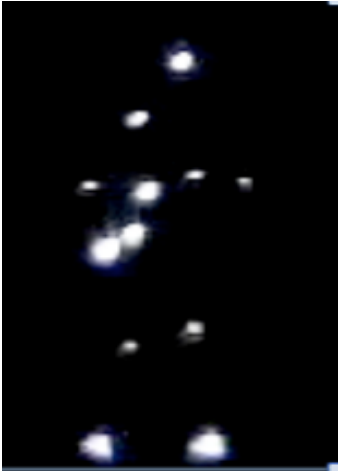
across the screen. Table 2.4 shows a still image of the clips for each emotion and for the neutral state. In addition, an example of a clip for ‘fear’ can be viewed at:

<http://www.wjh.harvard.edu/~heberlein/CF36.qt>.

Studies 3.2 and 3.3 used 40 clips (4 emotions X 8 clips + 8 neutral clips), in which participants had to decide which emotion was being portrayed in a five alternative forced-choice paradigm (afraid, angry, happy, sad, or neutral). Five pseudo-randomised running orders were created and one of these was used for each participant. Five practice clips not shown in the main experiment were shown first, to make sure that participants were able to see a human figure moving and understood the task. There was no time limit for the task, which usually took approximately 10 minutes to complete.

The validity of this task has been established by showing that participants are able to infer emotional states from PLW (Heberlein et al., 2004). In addition, PLW has been used in people with schizophrenia (Brittain, Ffytche, & Surguladze, 2012; Couture et al., 2010), ASD (Hubert et al., 2007; Nackaerts et al., 2012), and AN (Zucker et al., 2013).

Table 2.4. Example of PLW stimuli: Still images for each emotion and neutral

				
Anger	Fear	Happiness	Sadness	Neutral

Source: Atkinson et al. (2004)

#### 2.4.3.1.1. Scoring system

Compared to facial expressions of emotions, the evidence of the universality of bodily expressions of emotion is less robust (Ekman & Friesen, 1974). Therefore, a scoring system for the recognition of emotions in body movements requires the incorporation of cultural differences. For this reason, the PLW task uses a ‘reference sample’ with the same cultural background of the study participants to determine which is the ‘correct’ emotion for each clip (Heberlein et al., 2004).

2.4.3.1.1.1. Reference sample: Following the procedures used in previous studies (e.g., Brittain et al., 2012; Heberlein et al., 2004), 15 women meeting criteria for the HC group (Table 2.1) were recruited to participate as a ‘reference sample’. Of note, these participants were not part of the HC group used in the studies included in this thesis, but only completed the PLW task to serve as ‘reference sample’ of the PLW task.

To ensure the absence of ED pathology, the ED module of the SCID-I (First et al., 2002) was conducted, height and weight were measured, and participants completed the demographic information sheet described in the ‘measures’ section of this chapter.

Participants rated the 32 emotional clips of the PLW task, using a forced-choice paradigm with four answer choices (angry, happy, fear, or sad). The neutral film clips, along with the neutral answer option were not used.

Results are shown in table 2.5. The majority of participants from the ‘reference sample’ were able to identify the emotion portrayed on the clip. Therefore each clip maintained its original category (e.g. a clip that was designed to show sadness, was recognised as ‘sadness’ by most of the participants, thus ‘sadness’ was considered the correct answer for scoring purposes).

**Table 2.5. Results from the ‘reference sample’ and final correct answer for each clip**

Clip number	Emotion intended	Frequency in Reference sample (%) n=15				Correct answer
		Anger	Fear	Happiness	Sadness	
1	Happiness	0	0	100	0	Happiness
2	Happiness	0	0	100	0	Happiness
3	Sadness	0	0	6.7	93.3	Sadness
4	Sadness	0	0	26.7	73.3	Sadness
5	Sadness	0	0	0	100	Sadness
6	Neutral	N/A	N/A	N/A	N/A	Neutral
7	Anger	100	0	0	0	Anger
8	Neutral	N/A	N/A	N/A	N/A	Neutral
9	Anger	100	0	0	0	Anger
10	Neutral	N/A	N/A	N/A	N/A	Neutral
11	Sadness	0	6.7	0	93.3	Sadness
12	Fear	0	80	20	0	Fear
13	Happiness	0	0	100	0	Happiness
14	Happiness	0	0	93.3	6.7	Happiness
15	Neutral	N/A	N/A	N/A	N/A	Neutral
16	Sadness	0	0	0	100	Sadness
17	Fear	0	93.3	6.7	0	Fear
18	Sadness	0	0	0	100	Sadness
19	Fear	0	86.7	0	13.3	Fear
20	Neutral	N/A	N/A	N/A	N/A	Neutral
21	Happiness	6.7	0	93.3	0	Happiness
22	Happiness	0	0	100	0	Happiness
23	Anger	100	0	0	0	Anger
24	Anger	93.3	6.7	0	0	Anger
25	Fear	0	100	0	0	Fear
26	Happiness	0	0	100	0	Happiness
27	Fear	0	93.3	0	6.7	Fear
28	Fear	0	100	0	0	Fear
29	Fear	0	100	0	0	Fear
30	Anger	100	0	0	0	Anger
31	Anger	80	20	0	0	Anger
32	Anger	100	0	0	0	Anger
33	Sadness	6.7	0	6.7	86.7	Sadness
34	Sadness	6.7	0	0	93.3	Sadness
35	Happiness	6.7	6.7	73.3	13.3	Happiness
36	Anger	93.3	0	6.7	0	Anger
37	Neutral	N/A	N/A	N/A	N/A	Neutral
38	Fear	0	73.3	6.7	20	Fear
39	Neutral	N/A	N/A	N/A	N/A	Neutral
40	Neutral	N/A	N/A	N/A	N/A	Neutral

Emotion intended: Emotion that was instructed to the actor to portray through body movements when developing the PLW clips; Frequency in reference sample: Percentage of participants from the ‘reference sample’ that labelled the clip as such emotion; Correct answer: Emotion that was considered ‘correct’ for the clip for scoring purposes.

The neutral clips were not shown to the reference sample, thus they were classified as ‘neutral’.

2.4.3.1.1.2. Proportional correctness scoring methods: The PLW task uses a proportional correctness scoring method to score each participant's answer. Instead of assigning a score only to the 'correct answer' considering any other answer as 'wrong', this scoring method assigns partial scores according to the results obtained in the 'reference sample', accepting that a certain degree of variability in the interpretation of emotions from body movements is normal (Heberlein et al., 2004). For example, as it can be seen in table 2.5, clip number 3 was identified as 'sadness' by 93.3% of the 'reference sample', but 6.7% of it labelled the clip as 'happiness'. Thus, the 'correct answer' is 'sadness', which is assigned a score of 1 ( $0.93/0.93$ ), but a partial score of 0.07 ( $0.07/0.93$ ) is assigned to the 'happiness' answer choice. All other answer choices are assigned a score of 0.

The scores assigned to each answer choice for each clip can be seen on table 2.6. These final scores were used to score the PLW task in study 3.2 and 3.3.

**Table 2.6. Final scores for PLW clips**

Clip number	Final scores				
	Anger	Fear	Happiness	Sadness	Neutral
1	0.00	0.00	1.00	0.00	0.00
2	0.00	0.00	1.00	0.00	0.00
3	0.00	0.00	0.07	1.00	0.00
4	0.36	0.00	0.00	1.00	0.00
5	0.00	0.00	0.00	1.00	0.00
6	0.00	0.00	0.00	0.00	1.00
7	1.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	1.00
9	1.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	1.00
11	0.00	0.07	0.00	1.00	0.00
12	0.00	1.00	0.25	0.00	0.00
13	0.00	0.00	1.00	0.00	0.00
14	0.00	0.00	1.00	0.07	0.00
15	0.00	0.00	0.00	0.00	1.00
16	0.00	0.00	0.00	1.00	0.00
17	0.00	1.00	0.07	0.00	0.00
18	0.00	0.00	0.00	1.00	0.00
19	0.00	1.00	0.00	0.15	0.00
20	0.00	0.00	0.00	0.00	1.00
21	0.07	0.00	1.00	0.00	0.00
22	0.00	0.00	1.00	0.00	0.00
23	1.00	0.00	0.00	0.00	0.00
24	1.00	0.07	0.00	0.00	0.00
25	0.00	1.00	0.00	0.00	0.00
26	0.00	0.00	1.00	0.00	0.00
27	0.00	1.00	0.00	0.07	0.00
28	0.00	1.00	0.00	0.00	0.00
29	0.00	1.00	0.00	0.00	0.00
30	1.00	0.00	0.00	0.00	0.00
31	1.00	0.25	0.00	0.00	0.00
32	1.00	0.00	0.00	0.00	0.00
33	0.08	0.00	0.08	1.00	0.00
34	0.07	0.00	0.00	1.00	0.00
35	0.09	0.09	1.00	0.18	0.00
36	1.00	0.00	0.07	0.00	0.00
37	0.00	0.00	0.00	0.00	1.00
38	0.00	1.00	0.09	0.27	0.00
39	0.00	0.00	0.00	0.00	1.00
40	0.00	0.00	0.00	0.00	1.00

*2.4.3.3. Spontaneous facial expression of emotions. Film clips task (Davies, Schmidt, Stahl, & Tchanturia, 2011)*

The film clips task was developed by Davies et al. (2011) to elicit positive and negative emotions (i.e. happiness/joy and sadness) in people with ED. In this task, participants watched two short film clips in a computer screen whilst their facial expression was recorded through a built-in camera in the computer.

The positive film clip used a scene from “Four Weddings and a Funeral” showing a humorous depiction of a wedding ceremony. The negative film clip was a scene from “Shadowlands” depicting a dying woman saying farewell to her son and husband. Each clip last approximately 2 minutes. A still of each film clip can be seen in figure 2.1.

A third film clip, of simulated waves, was used before and after each emotional clip as a neutral stimulus. The film clips were presented in a fixed order of positive, neutral and negative, to avoid carry over effect from the negative film clip (Orsillo, Batten, Plumb, Luterek, & Roessner, 2004).

To evaluate the extent to which each clip was able to produce an increase in emotions, participants completed the PANAS (Watson et al., 1988) before and after each film clip. In order to measure their facial emotional expression, records of participants’ facial expression were coded by 2 blind coders using Facial Action Coding System (FACS, Ekman, Friesen, & Hager, 2002b). This coding system is described in detailed in the ‘coding systems’ section of this chapter.

Study 4.1 describes the findings obtained for the positive emotions elicitation, and study 4.2 shows the results for negative emotions.

**Figure 2.1 Stills from film clips task**

1. Positive film clip: “Four weddings and a funeral”



2. Negative film clip: “Shadowlands”





#### *2.4.3.4. Posed facial expression of emotions task*

The posed facial expression of emotions task was developed for study 4.3 and it is based on a task used in a study of posed expressions in people with schizophrenia (Schwartz, Mastropalo, Rosse, Mathis, & Deutsch, 2006).

During the posed expression task participants were asked to generate a facial expression for five emotions (anger, disgust, fear, happiness, and sadness). Participants sat in front of a computer laptop with a built-in camera and were asked to “pose or show the computer a facial expression for ‘X’ (i.e., anger, disgust, fear, happiness, or sadness)”. Participants were asked to look straight at the camera to indicate the moment when they thought they were posing the facial expression at their best.

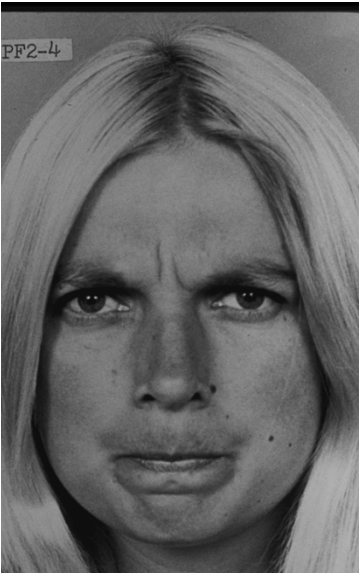

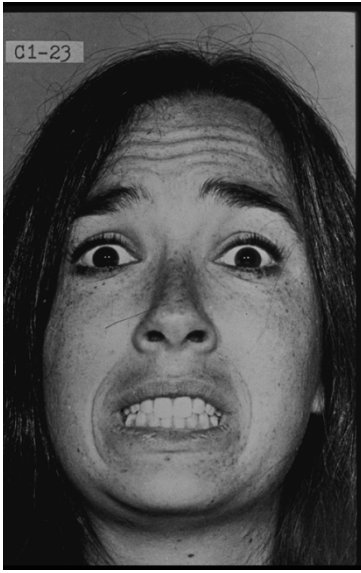

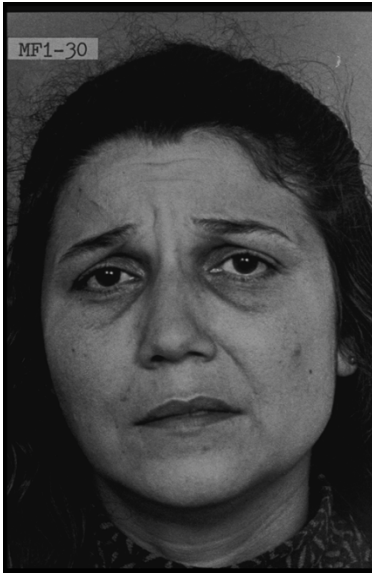
First, the investigator posed the emotion ‘surprise’ as an example, and made sure the participant had understood the instructions. Then, participants posed facial expressions for all five emotions. The order of emotions was random. Participants’ facial expression was recorded through the built-in camera in the computer.

For scoring purposes, all video records were inspected and pictures were taken at the moment participants looked straight at the camera. These pictures were coded according to certain guidelines. The coding system used is described in detail in the ‘coding systems’ section of this chapter.

#### *2.4.3.4. Imitated facial expressions of emotions task*

The imitation task used in study 4.3 is based on a previous study of imitated emotion expressions (Schwartz et al., 2006). During this task, participants were asked to imitate five female facial expressions of emotions taken from the Pictures of Facial Affect set of prototypical facial expressions for emotions (Ekman & Friesen, 1976). Examples of these pictures can be seen in table 2.7.

Table 2.7. Example of pictures used for imitation task

				
Anger	Disgust	Fear	Happiness	Sadness

Source: Ekman & Friesen et al. (1976)

Three randomisation lists with the pictures were made. Each participant was assigned to one randomisation list. The pictures were shown in a computer laptop screen, one at a time, and participants were asked to imitate the facial expression the best they could. They were instructed to look at the camera to indicate when they were best imitating the facial expression. As in the posed expression of emotions task, pictures were taken at the moment participants looked straight at the camera. These pictures were coded by a blind coder according to guidelines described in the 'coding systems' section of this chapter.

#### **2.4.4. Coding systems**

##### *2.4.4.1. Facial action coding system (FACS; Ekman, Friesen, & Hager, 2002a; Ekman et al., 2002b)*

In study 4.1 and 4.2, FACS was used to code the facial expression of participants. FACS is a comprehensive system developed with the aim of coding all visually distinguishable facial movements (Ekman et al., 2002a). The system was designed to be descriptive and free of theoretical inferences regarding the meaning of facial expressions.

FACS is based on the human face anatomy. Since all facial movements are the result of muscular action, FACS identifies how each muscle of the faces acts to change the facial appearance. Patterns of movements, such as temporary changes in shape and location of facial features, and the gathering, pouching, bulging and wrinkling of the skin are identified, to specify the muscular actions involved in each facial movement. FACS describes each of these muscular actions (named Action Units, AU) and their possible combinations, and uses them to code facial expression.

FACS describes 44 AU identifying them with the letters "AU", an arbitrary number, and a name. Table 2.8 shows an image for each AU. For each AU, the intensity of the action can be coded using a 5-point ordinal scale, from trace to maximum intensity.

**Table 2.8. Action Units identified by FACS**

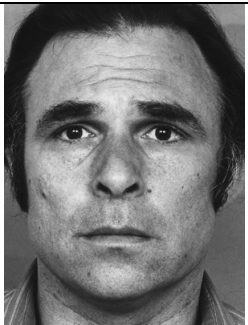
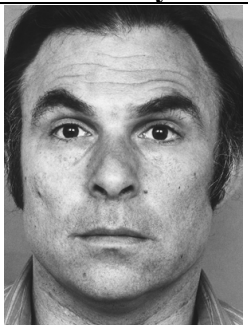
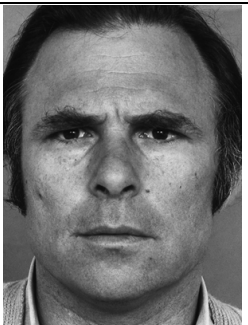
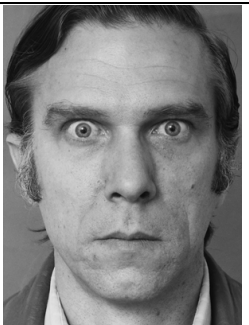
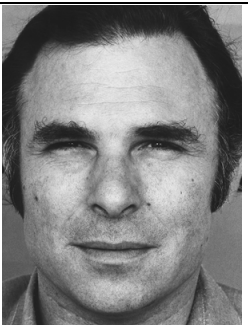
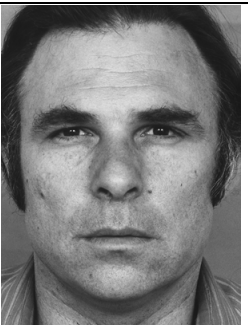

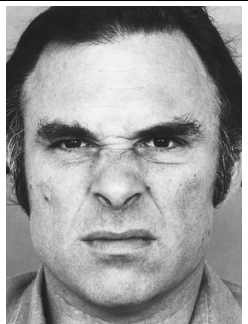
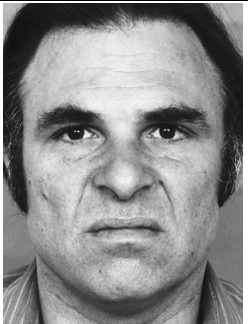
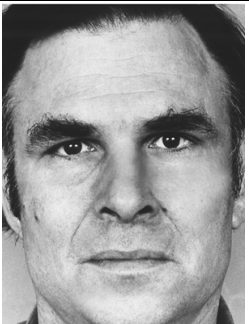
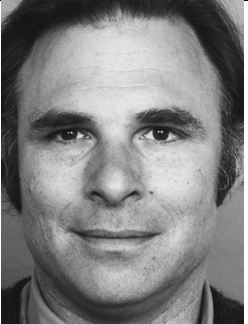
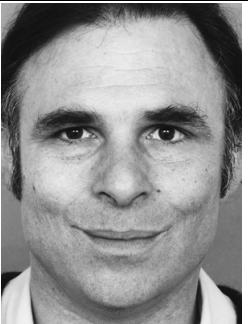
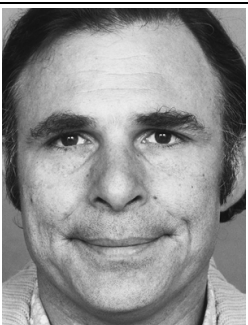
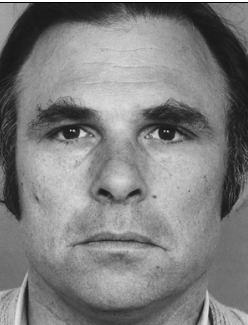
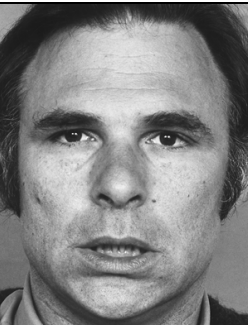
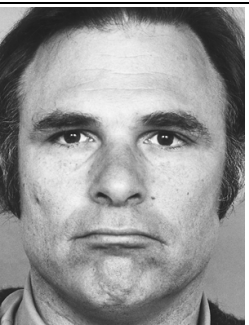
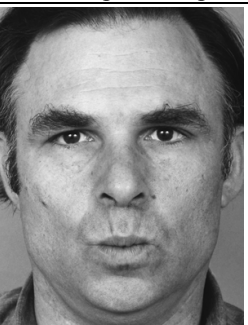

					
AU1: Inner brow raiser	AU2: Outer brow raiser	AU4: Brow lowerer	AU5: Upper lid raiser	AU6: Cheek raiser	AU7: Lid tightener
					
AU8: Lips t. each other	AU9: Nose wrinkler	AU10: Upper lip raiser	AU11: N. furrow deepen	AU12: Lip corner puller	AU13: Sharp lip puller
					
AU14: Dimpler	AU15: Lip corner depr.	AU16: Lower lip depr.	AU17: Chin raiser	AU18: Lip pucker	AU19: Tongue show

Table 2.8. (continued)

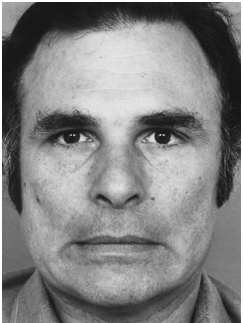
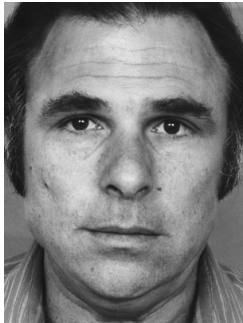
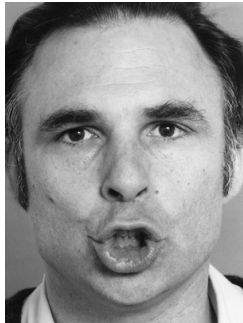
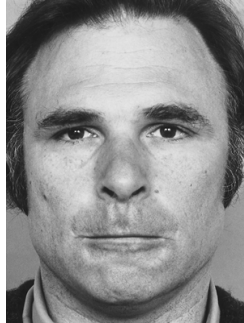
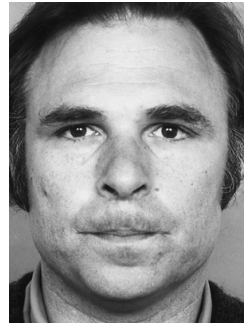
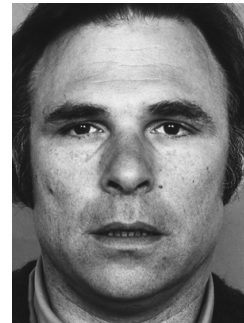
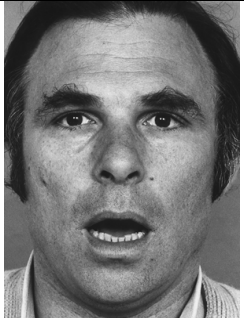
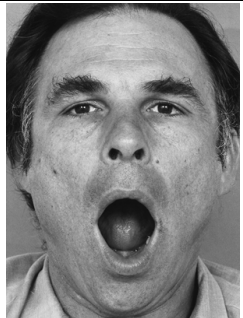
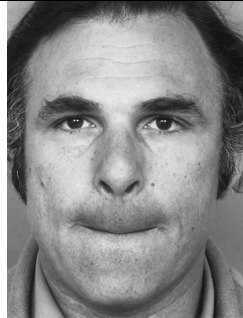
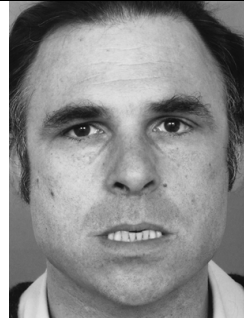





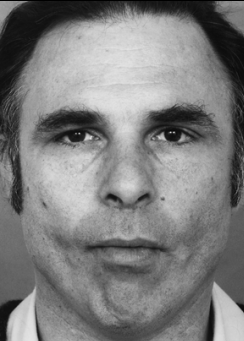


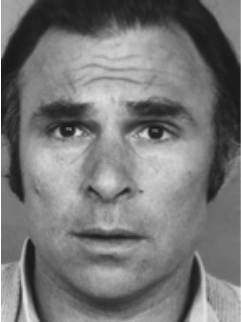

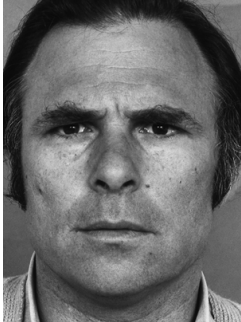
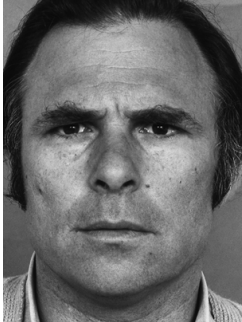
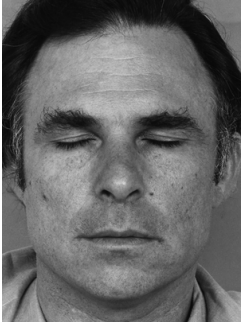
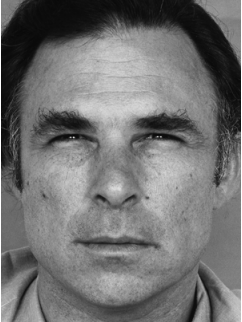
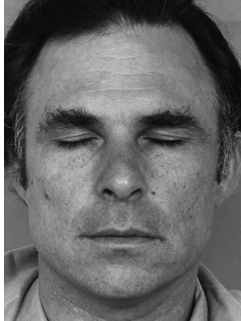

					
AU20: Lip stretcher	AU21: Neck tightener	AU22: Lip funneler	AU23: Lip tightener	AU24: Lip presser	AU25: Lips part
					
AU26: Jaw drop	AU27: Mouth stretch	AU28: Lips suck	AU29: Jaw thrust	AU30: Jaw sideways	AU31: Jaw clencher
					
AU32: Bite	AU33: Blow	AU34: Puff	AU35: Suck	AU36: Bulge	AU37: Lip wipe

Table 2.8. (continued)

 <p>AU38: Nostril dilator</p>	 <p>AU39: Nostril compres.</p>	 <p>AU41: Lid droop</p>	 <p>AU42: Slit</p>	 <p>AU43: Eye closure</p>	 <p>AU44: Squint</p>
 <p>AU45: Blink</p>	 <p>AU46: Wink</p>				

Source: Ekman et al., (2002b)

Most AU involve the action of a single muscle. However, there are some exceptions in which more than one muscle is involved in one AU (e.g., AU4 involves the action of the *depressor glabellae*, *depressor supercilli*, and *corrugator* muscles), or the action of one muscle is separated into two AU (e.g., both AU1 and AU2 describe the action of the *frontalis* muscle, but AU1 refers to the lift of the inner portion of the muscle or *pars medialis*, and AU2 describes its outer portion or *pars lateralis*). In addition to AU, FACS provides a code for head and eye position and movements.

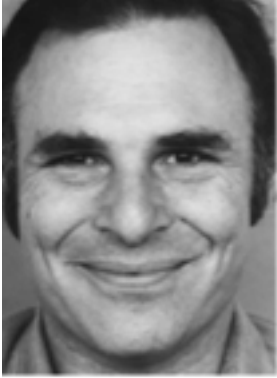

In order to describe complex facial expressions, FACS identifies which AU are involved in the facial movement, and combines them. These AU combinations are identified with the letters “AU” and the numbers of each AU involved along with plus signs (e.g., AU1+2).

Ekman et al. (2002a) have identified AU combinations that are typically shown when experiencing certain emotions. For study 4.1 and 4.2 all AU were coded and then these AU combinations were selected for analysis.

#### 2.4.4.1.1. Study 4.1: Duchenne and Non-Duchenne smile

Study 4.1 investigates spontaneous facial expressions of positive emotions, and focuses on two specific facial expressions: the Duchenne smile (DS) and Non-Duchenne smile (NDS). The DS is characterized by the activation of the *orbicularis oculi* producing wrinkles in the corner of the eyes (AU 6), in addition to the *zygomaticus major*, which moves the corner of the lips upwards towards the cheekbones (AU 12). FACS codes for DS and NDS can be seen in table 2.9.

**Table 2.9. FACS codes for Duchenne and Non-Duchenne smile**

Duchenne smile	Non-Duchenne smile
	
AU 6+12	AU 12



#### 2.4.4.1.2. Study 4.2: Facial expressions of sadness and other negative emotions

Study 4.2 investigates spontaneous facial expressions of sadness and other negative emotions (i.e., anger, fear, and disgust). Many AU are involved in the expression of these emotions. Table 2.10 shows the AU and AU combinations that were considered in study 4.2.

2.4.4.1.3. Coders' training and reliability: Using FACS to code facial expression requires extensive training. It has been estimated that a coder needs around 100 hours to learn the system (Ekman et al., 2002a). All coders of studies 4.1 and 4.2 as well as the candidate obtained certification as FACS coders prior to start coding the videos. In order to ensure inter-coder reliability, monthly meetings lead by the candidate were held to discuss difficult expressions and to solve questions. Inter-coder reliability was calculated using Cohen's Kappa coefficient. This is reported on each study section.

**Table 2.10. FACS codes for negative emotions**

Emotion	AU	Emotion	AU
Sadness	AU1	Anger	AU4
	AU1+4		AU23
	AU1+4+11		AU24
	AU1+4+15		AU4+5
	AU1+4+15+17		AU4+5+7
	AU6+15		AU10+22
Fear	AU1+2+4+5		AU10+23
	AU1+2+4+5+25,26, or 27		AU4+5+7+10+22
Disgust	AU9		AU4+5+7+10+22
	AU10		AU17+23
	AU9+16+15		AU17+24
	AU10+16+25 or 26		AU4+5+7+23
	AU9+17		AU4+5+7+24
	AU10+17		

Based on Ekman et al. (2002a)

#### *2.4.4.2. Coding system for posed and imitated facial expressions*

Study 4.3 used a judge-based system to rate facial expressions. In order to rate the accuracy of the facial expressions shown by participants, a 6-point Likert scale was built and two guidelines were developed, one for posed facial expressions of emotions and one for imitated facial expressions.

2.4.4.2.1. Guideline for posed facial expressions of emotions: In the posed expression task, the blind rater examined how accurately the participant posed each of the 5 basic emotions assessed (i.e., anger, disgust, fear, happiness, and sadness); the coder compared the facial expression shown by the participant with the prototypical features of the facial expression for that emotion. To aid the rater, a guideline was built, which included descriptions of typical facial features for each emotion taken from Ekman and Friesen (2003). These features were described in Chapter 1 and summarised in table 1.2. The guideline also included examples of facial expressions for each emotion.

For the 6-point Likert scale, the guideline included descriptions for each score, which are shown in table 2.11.

2.4.4.2.2. Guideline for imitated facial expressions of emotions: For the scoring of the imitation task, a computer display presentation was created showing pairs of pictures on each view (i.e., the model's facial expression and the participant's imitation of the model). The blind rater had to rate how well the imitated facial expression matched the model, using a 6-point Likert scale. In order to aid the ratings, a guideline was built with descriptions for each score. This guideline is described in table 2.12.

**Table 2.11. Guideline for posed facial expressions of emotions**

Score	Description
1: Not at all accurate	None of the characteristic features of the facial expression are present
2: Barely accurate	One or 2 characteristic features might be present, but insufficient to figure out the expression they represent
3: Somewhat accurate	The emotion showed is confusing, but it can be identified. Some characteristic features are present, but they are not enough to avoid hesitation
4: Reasonably accurate	The emotion can be clearly identified by key characteristic features. Nevertheless, it is too imprecise or inaccurate to be categorized as a good match or a good example of the emotion represented
5: Mostly accurate	Most of the characteristic features are present and accurately shown, and the emotion can be clearly identified. However, some features are still missing or are shown slightly inaccurately
6: Perfectly accurate	All characteristic features of the facial emotional expression are present and accurately portrayed

**Table 2.12. Guideline for imitated facial expressions of emotions**

Score	Description
1: No match at all	None of the characteristic features of the model's expression is present or recognisable
2: Barely accurate match	One or 2 features of the model are present, but they are clearly insufficient to establish clear correspondence between the model and the imitated expression
3: Somewhat accurate match	More than 2 features of the model can be identified in the imitated expression, but they are confusing or too inaccurate and it is not possible to establish a clear correspondence with the model
4: Reasonably accurate match	It is possible to establish a clear correspondence between the model and the imitated expression. Nevertheless, the features showed in the imitated expression are too imprecise or inaccurate to be categorised as a good match
5: Mostly accurate match	Most of the features are present and accurately shown, so the correspondence is clear and the whole expression can be categorized as a good match. However, a few features are still missing or inaccurate
6: Perfect match	All characteristic features of the model are present and accurately portrayed

2.4.4.2.3. Inter-rater reliability: To ensure inter-rater reliability 3 meetings were held, in which pictures of participants' facial expressions were randomly selected and rated by the blind rater and the candidate. Discrepancies in ratings were discussed.

Inter-rater reliability was assessed using Intra-class correlation coefficient and is reported in the respective study.

## **2.5. DATA ANALYTIC PLAN**

### **2.5.1. Sample size calculation**

Sample sizes for each study were estimated using G\*Power software (Faul, Erdfelder, Lang, & Buchner, 2007). When studies with ED participants were not available, studies using the same experimental tasks in other clinical populations, such as schizophrenia and ASD, were reviewed. The analyses were conducted assuming 80% statistical power to detect a medium effect size (Cohen's  $d=0.5$ ) at a level of significance of 0.01.

#### *2.5.1.1. Facial emotion recognition task (FEEST)*

No previous studies had used FEEST to assess facial emotion recognition in participants with ED, therefore, a study on high-functioning ASD participants was used for the estimation of sample size (Humphreys et al., 2007). It was estimated that a minimum of 25 participants were needed per group.

#### *2.5.1.2. Body motion emotion recognition task (PLW)*

At the time of sample size calculations, no study had used PLW in people with ED. Therefore; a study on individuals with schizophrenia was used for the calculation (Brittain et al., 2012). It was estimated that a minimum of 25 participants were needed per group.

#### *2.5.1.3. Film clips task*

Given that studies using FACS were not available in participants with ED, two studies investigating facial expression of emotions after a mood elicitation in people with schizophrenia and depression were used to estimate the sample size (Berenbaum & Oltmanns, 1992; Tremeau et al., 2005). It was estimated that a minimum sample size of 20 participants per group was needed.

#### *2.5.1.4. Posed and imitated facial expressions of emotions*

These tasks were based on a study investigating posed and imitated facial expressions in people with schizophrenia (Schwartz et al., 2006). Thus, the same study was considered for sample size calculations. It was estimated that a minimum sample size of 20 participants per group was needed.

### **2.5.2. Statistical analysis**

SPSS version 22 or STATA version 12 were used for data analysis. In all studies distributions were examined to evaluate normality and to assess the possibility of bi-modal distribution. There were no signs of bi-modal distribution of the data. In general, when data were normally distributed, parametric tests were used. When data were not normally distributed, attempts were made to transform the data. When those attempts did not succeed, data were analysed using non-parametric test.

Differences between 2 groups (e.g. AN vs. HC) were analysed using Mann Whitney U test. The only exception to this was study 3.2 in which, given its large sample size and characteristics of the variables' distributions, median regression was used. Differences amongst 3 groups (e.g., AN vs. BN vs. HC) were analysed using Kruskal-Wallis test. For data that were normally distributed, Factorial ANOVA was carried out using groups (i.e., AN, BN and HC) and emotions (i.e., anger, disgust, fear, happiness and sadness) as

factors. Effect sizes were calculated by using Cohen's  $d$  for parametric tests, and Rosenthal's  $r$  for non-parametric tests.

When possible, the effect of confounder variables was controlled for using multiple linear regression. When data were not normally distributed, Spearman correlations were carried out within the clinical sample, to explore the association of clinical characteristics and the outcome variables.

Details for each study are presented in the respective section.

## **CHAPTER 3**

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### **EMOTION RECOGNITION IN PEOPLE WITH EATING DISORDERS**



## **OVERVIEW**

This chapter is dedicated to the investigation of emotion recognition in people with ED. It includes three studies, two of which have been published in peer-reviewed journals.

The chapter begins with a published study on emotion recognition in blended facial expressions of emotions in people with AN. This is followed by a further published study on emotion recognition from body movements in individuals with AN. The chapter ends with a study on emotion recognition from face and body movements in people with BN.

## **CHAPTER 3**

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### **STUDY 3.1. EMOTION RECOGNITION IN BLENDED FACIAL EXPRESSIONS IN WOMEN WITH ANOREXIA NERVOSA**

## **EMOTION RECOGNITION IN BLENDED FACIAL EXPRESSIONS IN WOMEN WITH ANOREXIA NERVOSA**

Facial expression is a powerful means to convey information about people's emotional experience (Ekman, 1992). Thus, the ability to recognise emotions in facial expressions can help individuals respond to others' demands, facilitating bonding, and social relationships (Matsumoto, Keltner, Shiota, O'Sullivan, & Frank, 2008).

This study investigated the ability to recognise emotions in blended facial expressions, in women with AN, compared with HC.

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## RESEARCH ARTICLE

# Emotion Recognition in Blended Facial Expressions in Women with Anorexia Nervosa

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## Abstract

People with anorexia nervosa (AN) have difficulties in the social domain, and problems in the ability to recognise emotions in people's faces may contribute to these difficulties. This study aimed to investigate emotion recognition in women with AN and healthy controls (HC), using pictures of faces portraying blended emotions at different levels of ambiguity, which resemble real-life expressions more closely than prototypical expressions used in past studies. Seventy-seven participants (35 AN; 42 HC) completed the emotion recognition task. Results indicated that participants with AN were less accurate than HC recognising expressions of disgust, when shown less ambiguously. There were no differences in the recognition of other emotions. Participants with AN also showed response bias towards anger. These findings suggest a generally preserved ability to recognise emotions in women with AN, with the exception of disgust recognition. They also support previous findings of bias towards anger in AN patients. Copyright © 2015 John Wiley & Sons, Ltd and Eating Disorders Association.

## Keywords

Emotion recognition; disgust; anorexia nervosa; eating disorders; face

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Social cognitive functioning and the processes associated with human social interaction rely heavily on the exchange of signals concerning emotional states, both verbal and nonverbal (Frith & Frith, 2007). Among the nonverbal, facial expression is one of the most powerful means for social signalling, conveying emotions (Horstmann, 2003), but also intentions, attentiveness, and identity (Bruce & Young, 1986). The ability to accurately decode facial emotional expressions plays a key role in social interaction (Kilts, Egan, Gideon, Ely, & Hoffman, 2003), allowing people to respond appropriately to others and facilitating bonding (Isaacowitz et al., 2007).

Difficulties in facial emotion recognition have been studied across a range of psychiatric disorders, such as depression (e.g. Surguladze et al., 2004), schizophrenia (e.g. Kohler, Walker, Martin, Healey, & Moberg, 2010), autism (e.g. Humphreys, Minshew, Leonard, & Behrmann, 2007), and borderline personality disorders (e.g. Domes, Schulze, & Herpertz, 2009), and are also an important area of investigation in eating disorders (Oldershaw et al., 2011; Russell, Schmidt, Doherty, Young, & Tchanturia, 2009). Moreover, a recent review of emotion processing difficulties in psychiatric disorders has shown that studies using fMRI have identified similar brain regions to be impaired in emotion processing tasks, concluding that difficulties in this area might underlie many different mental disorders, including eating disorders (Kret & Ploeger, 2015).

Whilst eating disorders are characterised by disturbances in eating patterns and negative feelings about body shape and weight (American Psychiatric Association, 2013), they are often accompanied by problems in different aspects of social cognition (for a review, see Caglar-Nazali et al., 2014). Patients with eating disorders, particularly with anorexia nervosa (AN), have shown high levels of social anhedonia (Tchanturia et al., 2012), as well as poor social functioning (Tchanturia et al., 2013).

In addition, people with eating disorders report high levels of alexithymia (Nowakowski, McFarlane, & Cassin, 2013) and emotion avoidance (Wildes, Ringham, & Marcus, 2010; Davies, Schmidt, Stahl, & Tchanturia, 2011), and it has been proposed that eating disorder behaviours can function as emotion regulation strategies, reducing the anxiety and distracting the patient from strong emotions. Thus, difficulties in emotion processing could contribute to the maintenance of the eating disorder (Treasure, & Schmidt, 2013). Problems in emotion recognition may be at the basis of some of these difficulties.

Preliminary studies on facial emotion recognition have found that patients with AN were less accurate than healthy controls (HC) identifying all emotions, suggesting a generalised difficulty (Jansch, Harmer, & Cooper, 2009; Zonnevijlle-Bender, van Goozen, Cohen-Kettenis, van Elburg, & van Engeland, 2002). A more nuanced viewpoint has developed from more recent studies,

which have found that the level of accuracy depends on the emotion presented. For example, three studies have reported lower accuracy in AN participants compared to HC when recognising sadness (Castro, Davies, Hale, Surguladze, & Tchanturia, 2010; Kucharska-Pietura, Nikolaou, Masiak, & Treasure, 2004; Pollatos, Herbert, Schandry, & Gramann, 2008), two studies have found difficulties recognising disgust (Lule et al., 2014; Pollatos et al., 2008), and one study showed poorer recognition of fear in individuals with AN (Kucharska-Pietura et al., 2004). These studies did not find problems recognising other emotions in AN participants. Of note, there are studies that have not found meaningful differences between people with AN and HC on facial emotion recognition (Kessler, Schwarze, Filipic, Traue, & von Wietersheim, 2006; Mendlewicz, Linkowski, Bazelmans, & Philippot, 2005).

In addition, previous studies have identified clinical characteristics that might be associated with difficulties in AN facial emotion recognition. For example, people with high levels of comorbid depression and obsessive-compulsive symptoms are more likely to have reduced emotion recognition accuracy (Castro et al., 2010; Jansch et al., 2009; Lule et al., 2014), and this may also be true for AN patients who are taking psychotropic medication (Jansch et al., 2009). Moreover, alexithymia (i.e. difficulty identifying and labelling emotions) has been linked to worse emotion recognition (Zonnevijlle-Bender et al., 2002), and Brewer and colleagues (2015) have proposed that such difficulties are due to having alexithymia and not the eating disorder *per se*. According to this approach, variations in emotional recognition found in previous studies may be explained by differences in levels of alexithymia (Brewer et al., 2015).

The studies overall suggest that reduced emotion recognition may be relatively subtle, with not all the tasks used in previous studies being particularly sensitive to slight impairment. Most of the studies have used pictures of faces portraying prototypical expressions of emotions, in which a single emotion is depicted very intensely. Instead, real-life facial expressions are usually ambiguous and often involve blended emotions (Buisine et al., 2006). These more ambiguous facial expressions may be more challenging for people with subtle but nevertheless socially debilitating difficulties in emotion recognition. There is preliminary evidence of poorer performance in subtle displays of emotions in nonclinical participants with disordered eating behaviour (Ridout, Wallis, Autwal, & Sellis, 2012), but the ability to recognise emotions in ambiguous, blended facial expressions in people with AN is still unknown.

Another relevant feature of facial emotional processing is the extent to which people misclassify or exhibit a bias towards certain emotions when interpreting emotional facial expressions, as these biases can distort the assessment of differences in emotion recognition among groups (Isaacowitz et al., 2007). There is some evidence suggesting that this may be the case in AN. Studies have demonstrated that people with AN exhibit attentional biases towards angry and rejecting faces (Cardi, Di Matteo, Corfield, & Treasure, 2013; Harrison, Sullivan, Tchanturia, & Treasure, 2010; Harrison, Tchanturia, & Treasure, 2010), indicating that AN participants show a disproportionate preference for anger, compared to HC. Out of the large number of studies examining facial emotion recognition in AN, two of them assessed

bias in the participant's responses, with Jansch and collaborators (2009) reporting that AN participants misclassified more emotions than HC, and Castro and collaborators (2010) not finding evidence of bias towards sad or happy faces in AN participants.

The current study aimed to build upon these findings, evaluating the ability to recognise emotions in ambiguous facial expressions, using pictures of faces portraying blended emotions. Blended facial expressions were used instead of prototypical, in order to increase the sensitivity of the measurement and to make it more naturalistic. In addition, the study aimed to investigate patterns of response bias in AN, and based on previous findings, it was hypothesised that participants with AN would exhibit a bias towards anger. Finally, a secondary objective was to explore associations between clinical features, medications, and alexithymia and emotion recognition in AN.

## Materials and methods

### Participants

The study included 35 AN participants (17 restricting type and 18 binge-eating/purging type) and 42 healthy controls (HC), matched across groups by age and years of education, all female. AN participants were included in the study if they met DSM-5 (American Psychiatric Association, 2013) criteria for AN, assessed using the eating disorders module of the Structured Clinical Interview for DSM-IV-TR Axis I Disorders (SCID-I) (First, Gibbon, Spitzer, & Williams, 2002), and a body mass index lower than 18.5 kg/m<sup>2</sup>. HC participants were included if they had no current or past diagnosis of eating disorders, evaluated with the SCID, and a body mass index (BMI) higher than 18.5 kg/m<sup>2</sup>. Exclusion criteria for all groups were presence of head injury, autistic spectrum disorders, psychosis, not being fluent in English, or inability to provide informed consent. Participants with AN were recruited from specialist eating disorders services and through advertisement on the Beat website (<http://www.b-eat.co.uk/>). The HC group was recruited from the local community through advertisement in the university circular and community centres, libraries, etc. Participants were compensated for their time with £10.

### Measures

#### Body mass index (kg/m<sup>2</sup>)

This was determined by measuring height and weight of participants on the day of the assessment.

#### Structured Clinical Interview for DSM-IV-TR Axis I Disorders (First et al., 2002)

The eating disorders module of the SCID-I was used to assess current AN diagnosis and history of ED. In order to adjust the interview for assessing DSM-5 criteria, amenorrhea was not required for AN diagnosis, and the frequency of binge eating and purging behaviour was reduced to once a week for the diagnosis of BN.

### **Eating Disorder Examination Questionnaire (Fairburn & Beglin, 1994)**

The Eating Disorder Examination Questionnaire (EDE-Q) is a 36-item self-report measure that assesses cognitions and behavioural features of eating disorders. The internal consistency for the EDE-Q global score in the current sample was  $\alpha = 0.98$ .

### **Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983)**

The Hospital Anxiety and Depression Scale is a 14-item self-report questionnaire developed to assess anxiety and depression in patients attending nonpsychiatric clinics and shown to have adequate validity and reliability (Bjelland, Dahl, Haug, & Neckelmann, 2002). In the current study, only the depression scale items were used, these yielding an internal consistency of  $\alpha = 0.64$ .

### **Obsessive–Compulsive Inventory Revised (Foa et al., 2002)**

The Obsessive–Compulsive Inventory Revised is an 18-item self-report questionnaire, scored on a 5-point Likert scale that has been used in people with eating disorders (Roberts, Lavender, & Tchanturia, 2011). The questionnaire has shown good internal consistency, convergent validity, and test–retest reliability (Foa et al., 2002). Internal consistency in this study was  $\alpha = 0.96$ .

### **Toronto Alexithymia Scale-20 (Bagby, Parker, & Taylor, 1994)**

The Toronto Alexithymia Scale-20 is a 20-item self-report questionnaire aimed to evaluate alexithymia. It has been widely used and has shown to be a reliable and valid measure for alexithymia (Bagby, Taylor, & Parker, 1994; Parker, Taylor, & Bagby, 2003). Internal consistency in this study was  $\alpha = 0.92$ .

### **Facial emotion recognition task**

Stimuli were taken from the Facial Expressions of Emotion: Stimuli and Test set of morphed facial expressions (Young, Perret, Calder, Sprengelmeyer, & Ekman, 2002). This set contains black and white pictures of facial expressions of blended emotions, and it was developed by morphing prototypic expressions of happiness, fear, sadness, disgust, and anger, into pairwise combinations (for a detailed explanation, see Young et al., 1997). Five morphed images were created using the following proportions: 90:10 (e.g. 90% happiness, 10% fear), 70:30 (e.g. 70% happiness, 30% fear), 50:50 (e.g. 50% happiness, 50% fear), 30:70 (e.g. 30% happiness, 70% fear), and 10:90 (e.g. 10% happiness, 90% fear). In the current study, 10 combinations were used (i.e. happiness–fear, happiness–sadness, happiness–disgust, happiness–anger, fear–sadness, fear–disgust, fear–anger, sadness–disgust, sadness–anger, disgust–anger) with five morphed images using the different proportions (i.e. 90:10, 70:30, 50:50, 30:70, and 10:90) per combination type, providing a total of 50 faces. By using male and female faces, the total was doubled to 100 faces (10 combination types  $\times$  5 proportions  $\times$  2 genders). The reliability and validity of the stimuli have been established in previous studies with healthy individuals (Young et al., 1997; Young et al., 2002). The set of faces has also been used in studies of facial emotion

recognition in people with autism (Humphreys et al., 2007), obsessive–compulsive disorder (Jhung et al., 2010), and borderline personality disorder (Domes et al., 2008).

Pictures were randomised and presented on a grey background on a computer screen, along with five answer choices (afraid, angry, disgusted, happy, or sad). Participants had to select the answer choice that best described the facial expression, in a forced-choice paradigm. The 100 pictures were presented three times, in different order, with a 5-minute rest interval between each block of faces. The task took approximately 30 minutes to complete.

Percentage of correct response was obtained for each emotion at 90% (i.e. 90:10) and 70% (i.e. 70:30) proportion. For example, in order to calculate the results for anger at 90%, the percentage time the participant selected ‘anger’ for all faces containing anger at 90% was recorded (i.e. for the faces in which anger was mixed with either 10% disgust, fear, happiness, or sadness) (Humphreys et al., 2007). Given that in the pictures showing emotions at 50% (i.e. 50:50) proportion there are two ‘correct’ responses, for the purpose of analysis, the percentage of responses for both ‘correct’ answers was considered. For example, in a picture depicting 50% anger and 50% disgust, both emotions were considered ‘correct’ (Humphreys et al., 2007). In order to obtain response bias scores, the opposite process was carried out. Thus, the percentage time a participant selected an ‘incorrect’ response was calculated. For example, in order to calculate the scores for response bias towards anger at 90%, the percentage of ‘anger’ response to all 90% proportion stimuli that did not contain anger was recorded (Isaacowitz et al., 2007).

### **Procedures**

Participants attended one session in which height and weight were measured, and the interview was conducted. Afterwards, participants completed the emotion recognition task and filled in self-report questionnaires. The study was approved by the NHS Research Ethics Committee, reference number 13/LO/0201. Informed consent was obtained from all participants.

### **Statistical analysis**

IBM SPSS version 22 (Armonk, NY: IBM Corp) was used for data analysis. First, distributions were examined to evaluate normality. In most cases, data were negatively skewed and transformations attempting to normalise the data were unsuccessful. In these cases, Mann Whitney *U* test was used to evaluate differences in emotion recognition between participants with AN and HC, and Rosenthal’s *r* effect size for nonparametric test was calculated. When data were normally distributed, a factorial 2  $\times$  5 ANOVA was used to examine the main effects of group (i.e. AN or HC), emotion (i.e. anger, disgust, fear, happiness, and sadness), and group  $\times$  emotion interaction, on emotion recognition accuracy. The same approach was used to examine response bias in AN participants. Within the AN sample, Spearman correlations were carried out to explore the association of clinical characteristics such as BMI, length of illness, anxiety, depression, obsessive–compulsive symptoms, and alexithymia, and recognition accuracy. To investigate the influence of medication in recognition accuracy, the AN sample was split into those who were using psychotropic medication and those who were not, and Mann

Whitney *U* test was carried out to test differences between both groups. Bonferroni correction for multiple testing was applied. For statistically significant results, both uncorrected and corrected *p* values are reported (corrected *p* values are referred as '*p*<sub>cor</sub>').

## Results

Participant's demographic and clinical characteristics are presented in Table 1. As expected, AN participants significantly differed from HC on BMI and measures of eating disorders symptoms, depression, obsessive-compulsive symptoms, and alexithymia. There were no differences in age and years of education between the groups, confirming the group matching on these variables.

Participants with AN had an average length of illness of over 10 years ( $M = 10.54$ ,  $SD = 9.16$ ), and the majority were receiving intensive treatment (43% inpatient, 20% intensive outpatient treatment). Sixty percent of the AN participants were taking psychotropic medication, in most cases selective serotonin re-uptake inhibitors (46%), olanzapine (17%), or benzodiazepines (9%).

Results for emotion recognition at each proportion type are presented separately. Results are shown in detail for emotions depicted at a 90% proportion and in a more succinct manner for those portrayed at 70% and 50% proportion. Overall results can be seen in Figure 1.

### Emotion recognition at 90%

#### Accuracy

Mean percentage accuracy for all emotions is shown in Table 2.

Results from Mann Whitney *U* test indicated that participants with AN were significantly less accurate recognising disgust depicted at a proportion of 90% [ $U(75) = 410.00$ ;  $p < 0.01$ ;  $p_{cor} < 0.01$ ;  $r = -0.39$ ]. In addition, people with AN were less accurate than HC recognising fear; however, after correcting for multiple testing, the difference was no longer significant [ $U(75) = 580.00$ ;  $p = 0.04$ ;  $p_{cor} = 0.20$ ;  $r = -0.23$ ]. There were no differences between AN and HC groups in recognition accuracy for other emotions at this proportion [Anger:  $U(75) = 757.50$ ;

$p = 0.82$ ; Happiness:  $U(75) = 776.00$ ;  $p = 0.45$ ; Sadness:  $U(75) = 701.00$ ;  $p = 0.67$ ].

Further examination of the responses through a confusability matrix showed that most of the AN participants who did not recognise disgust misinterpreted it as anger (see Table 3 for confusability matrix for AN and HC groups).

#### Response bias

Mean response bias for all emotions is reported in Table 4. Mann Whitney *U* test was carried out to evaluate differences between AN and HC groups. The AN group had a higher preference to interpret non-angry faces as anger, when compared to HC [ $U(75) = 1,036.50$ ;  $p < 0.01$ ;  $p_{cor} = 0.01$ ;  $r = 0.36$ ], showing a response bias towards anger. There was no evidence of response bias for other emotions [Disgust:  $U(75) = 826.00$ ;  $p = 0.32$ ; Fear:  $U(75) = 652.00$ ;  $p = 0.39$ ; Happiness:  $U(75) = 735.00$ ;  $p = 1.00$ ; Sadness:  $U(75) = 807.00$ ;  $p = 0.35$ ].

The response bias towards anger was further explored by performing two additional analyses: First, the pictures in which anger was portrayed at a 10% proportion (with any other emotion being depicted at 90%) were analysed. Results from Mann Whitney *U* test indicated that the AN group had a higher preference to interpret these faces as anger [ $U(75) = 971.00$ ;  $p = 0.01$ ;  $r = 0.29$ ]. Then, the pictures in which there were no signs of anger (i.e. pictures in which anger was portrayed either at 90% or 10% proportion were excluded) were analysed. Results showed that participants with AN also had a higher preference to interpret these faces as anger [ $U(75) = 1060.50$ ;  $p < 0.01$ ;  $r = 0.40$ ].

### Emotions at 70%

#### Accuracy

Mean percentage accuracy for all emotions is presented in Table 2. The results from Mann Whitney *U* test indicated that AN participants did not differ from HC in their ability to recognise emotions shown at this proportion [Anger:  $U(75) = 566.50$ ;  $p = 0.08$ ; Disgust:  $U(75) = 573.50$ ;  $p = 0.09$ ; Fear:  $U(75) = 717.50$ ;  $p = 0.85$ ; Happiness:  $U(75) = 852.50$ ;  $p = 0.09$ ; Sadness:  $U(75) = 716.50$ ;  $p = 0.85$ ].

#### Response bias

Table 4 shows mean response bias for all emotions. AN participants did not differ from HC [Anger:  $U(75) = 865.50$ ;  $p = 0.18$ ; Disgust:  $U(75) = 797.00$ ;  $p = 0.52$ ; Fear:  $U(75) = 859.00$ ;  $p = 0.20$ ; Happiness:  $U(75) = 762.00$ ;  $p = 0.76$ ; Sadness:  $U(75) = 634.00$ ;  $p = 0.28$ ].

### Emotions at 50%

#### Accuracy

Mean percentage response for all emotions is shown in Table 2. Data were normally distributed; therefore, factorial ANOVA was carried out with two groups (i.e. AN and HC) and five emotions (i.e. anger, disgust, fear, happiness, and sadness) as factors. Results indicated that there was no significant main effect of group on the percentage response, meaning that AN participants did

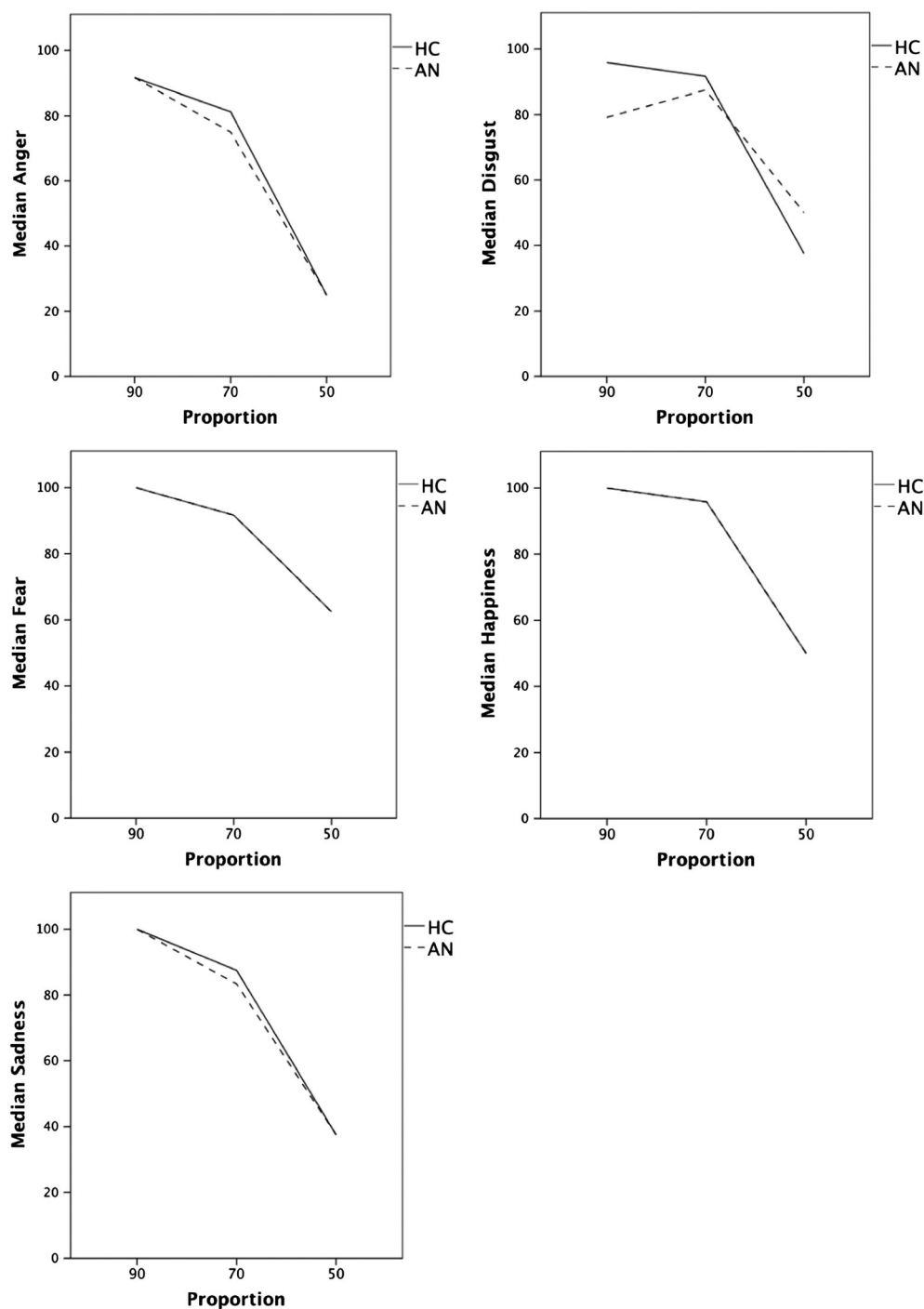
**Table 1** Participant's demographic and clinical characteristics

	AN ( <i>n</i> = 35)		HC ( <i>n</i> = 42)	
	Mean	SD	Mean	SD
Age	27.54	8.36	26.98	7.55
Years of education	16.15	3.13	17.68	2.94
BMI*	15.33	1.74	22.53	2.63
EDE-Q*	4.26	1.20	0.56	0.49
HADS-D*	10.31	3.52	3.74	1.29
OCI-R *	28.20	17.32	4.19	3.68
TAS-20 *	59.91	12.43	34.48	6.65

AN, anorexia nervosa; HC, healthy controls; SD, standard deviation; BMI, body mass index; EDE-Q, Eating Disorder Examination Questionnaire; HADS-D, Hospital Anxiety and Depression Scale—Depression scale; OCI-R, Obsessive-Compulsive Inventory Revised; TAS-20, Toronto Alexithymia Scale-20.

\*Mean difference is statistically significant,  $p < 0.01$ .





**Figure 1.** Median percentage response for each emotion at 90%, 70%, and 50%

not differ from HC [ $F(1, 375) = 0.08, p = 0.78$ ]. There was a main effect of emotion, indicating that not all emotions were recognised equally [ $F(4, 375) = 50.26, p < 0.01$ ]. Tukey post-hoc test showed that fear and happiness were the emotions to be more likely to be selected by all participants, followed by disgust, whereas sadness and anger were the emotions with the lowest selection (all differences with  $p < 0.01$ ). Finally, the effect of the

group \* emotion interaction was not significant [ $F(4, 375) = 1.67, p = 0.16$ ], indicating that the effects of emotion were similar for AN and HC participants.

### Response bias

Mean response biases are presented in Table 4. Data were not normally distributed; thus, Mann Whitney  $U$  test was used. There



**Table 2** Percentage responses for emotions at 90%, 70%, and 50%

	AN ( <i>n</i> = 35)				HC ( <i>n</i> = 42)			
	Mean	SD	Mdn	IQR	Mean	SD	Mdn	IQR
Anger 90%	87.02	14.57	91.67	16.67	86.71	14.10	91.67	17.71
Disgust 90%	76.31	23.43	79.17	37.50	92.96	11.55	95.83	8.33
Fear 90%	94.29	17.97	100.0	4.17	99.11	2.17	100.0	0.00
Happiness 90%	99.17	3.62	100.0	0.00	98.91	4.02	100.0	0.00
Sadness 90%	96.79	7.10	100.0	4.17	98.31	3.06	100.0	4.17
Anger 70%	71.90	13.83	75.00	16.67	76.39	14.71	81.25	26.04
Disgust 70%	80.71	19.75	87.50	29.17	88.49	13.55	91.67	20.83
Fear 70%	87.98	17.20	91.67	12.50	91.27	5.43	91.67	8.33
Happiness 70%	93.69	8.17	95.83	0.00	92.46	8.55	95.83	4.17
Sadness 70%	82.50	12.29	83.33	12.50	84.13	8.09	87.50	8.33
Anger 50%	29.29	16.59	25.00	25.00	27.98	13.75	25.00	25.00
Disgust 50%	47.14	29.58	50.00	25.00	43.75	14.41	37.50	12.50
Fear 50%	57.50	15.81	62.50	12.50	62.50	12.95	62.50	25.00
Happiness 50%	59.64	23.30	50.00	37.50	52.68	20.39	50.00	28.13
Sadness 50%	30.36	17.23	37.50	12.50	34.52	15.07	37.50	25.00

AN, anorexia nervosa; HC, healthy controls; SD, standard deviation; Mdn, median; IQR, interquartile range.

**Table 3** Confusability matrix for emotions at 90%

	Emotion portrayed (i.e. correct response)				
	Anger (%)	Disgust (%)	Fear (%)	Happiness (%)	Sadness (%)
<i>AN response</i>					
Anger	<b>87.0</b>	21.5	3.6	0.1	1.2
Disgust	6.4	<b>76.3</b>	2.0	0.1	0.8
Fear	6.4	0.1	<b>94.3</b>	0.2	1.2
Happiness	0.0	0.0	0.0	<b>99.2</b>	0.0
Sadness	0.1	2.0	0.1	0.4	<b>96.8</b>
Total	100.0	100.0	100.0	100.0	100.0
<i>HC response</i>					
Anger	<b>86.7</b>	5.9	0.4	0.2	0.4
Disgust	3.6	<b>93.0</b>	0.4	0.1	0.3
Fear	9.4	0.2	<b>99.1</b>	0.2	1.0
Happiness	0.0	0.0	0.0	<b>98.9</b>	0.0
Sadness	0.3	1.0	0.1	0.6	<b>98.3</b>
Total	100.0	100.0	100.0	100.0	100.0

AN, anorexia nervosa; HC, healthy controls. Percentages in bold represent the percentage of correct response.

were no differences between AN and HC participants, showing no evidence of response bias [Anger:  $U(75) = 642.50$ ;  $p = 0.30$ ; Disgust:  $U(75) = 729.50$ ;  $p = 0.94$ ; Fear:  $U(75) = 690.50$ ;  $p = 0.63$ ; Happiness:  $U(75) = 735.00$ ;  $p = 1.00$ ; Sadness:  $U(75) = 715.00$ ;  $p = 0.76$ ].

### Clinical characteristics associated with poor disgust recognition

The relationships of clinical characteristics that have been linked to poor emotion recognition in previous studies in AN, and impairment in face emotion perception were explored. For this purpose, Spearman correlations were carried out within the AN

**Table 4** Response bias for emotions at 90%, 70%, and 50%

	AN ( <i>n</i> = 35)				HC ( <i>n</i> = 42)			
	Mean	SD	Mdn	IQR	Mean	SD	Mdn	IQR
Anger 90%	6.61	9.45	3.13	9.38	1.71	2.77	1.04	2.08
Disgust 90%	2.44	4.10	1.04	3.13	1.09	1.61	0.52	1.04
Fear 90%	1.90	2.08	1.04	3.13	2.70	3.15	2.08	3.39
Happiness 90%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sadness 90%	0.65	1.21	0.00	1.04	0.50	1.18	0.00	0.26
Anger 70%	7.23	8.91	5.21	7.29	4.49	3.00	4.17	4.17
Disgust 70%	3.54	4.26	2.08	4.17	2.51	2.25	2.08	2.34
Fear 70%	7.32	3.63	7.29	3.13	6.67	3.45	6.25	4.17
Happiness 70%	1.19	1.50	0.00	2.08	1.07	1.43	0.00	2.08
Sadness 70%	1.52	2.13	1.04	2.08	2.08	2.93	1.04	2.08
Anger 50%	6.43	8.35	0.00	8.33	6.75	5.28	8.33	8.33
Disgust 50%	2.86	6.37	0.00	0.00	2.78	6.29	0.00	0.00
Fear 50%	6.67	7.78	8.33	8.33	7.54	7.98	8.33	16.67
Happiness 50%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sadness 50%	1.43	3.19	0.00	0.00	1.98	4.44	0.00	0.00

AN, anorexia nervosa; HC, healthy controls; SD, standard deviation; Mdn, median; IQR, interquartile range.

sample ( $n = 35$ ) looking at the association of BMI, length of illness, depression, obsessive-compulsive symptoms, and alexithymia; and percentage correct response for disgust at 90%. Disgust recognition at the 90% proportion was selected because it was on this condition that differences between groups emerged in the previous analysis. Results indicated that BMI and length of illness were significantly associated with recognition accuracy of disgust at this proportion level. However, after correcting for multiple testing, these associations were no longer significant (BMI:  $r_s = 0.39$ ;  $p = 0.02$ ;  $p_{\text{cor}} = 0.11$ ; Length of illness:  $r_s = -0.34$ ;  $p = 0.047$ ;  $p_{\text{cor}} = 0.24$ ). All other clinical characteristics showed no significant association with disgust recognition accuracy (Depression:  $r_s = -0.09$ ;  $p = 0.60$ ; Obsessive-compulsive symptoms:  $r_s = -0.01$ ;  $p = 0.94$ ; Alexithymia:  $r_s = -0.04$ ;  $p = 0.80$ ).

Finally, the role of medications was explored by splitting the AN group into those who were using psychotropic medication ( $n = 21$ ) and those who were medication free ( $n = 14$ ). Mann Whitney  $U$  test was carried out to look at differences in disgust recognition accuracy between both groups. Results indicated that AN participants who were taking medications did not differ from those who were not using pharmacological treatment [ $U(33) = 138.50$ ;  $p = 0.78$ ].

## Discussion

The current study aimed to investigate the ability to recognise emotions in blended facial expressions in adult women with AN. Results indicated difficulties in the recognition of disgust, when displayed in less ambiguous facial expressions (i.e. in facial expressions that showed disgust at a 90% proportion). These findings partially support our hypothesis of subtle difficulties in emotion recognition in AN, by showing difficulties recognising only one emotion at a specific level of ambiguity, suggesting no general difficulty in emotion recognition in people with AN.

Emotion expressions are not processed by a single brain system, but different regions are implicated in the processing of

different emotions (Calder & Young, 2005). Thus, it is not surprising that the ability to recognise emotions might not be similar for all emotions. In this context, the study results support previous findings of difficulties in disgust recognition in AN (Lule *et al.*, 2014; Pollatos *et al.*, 2008). Moreover, it has been proposed that a dysfunction of the insula, which is the brain region implicated in the processing of disgust facial expressions (Phillips *et al.*, 1997), might be at the basis of eating pathology (Nunn, Frampton, Gordon, & Lask, 2008). According to this, a dysfunction of the insula could explain emotional processing difficulties in AN (Nunn, Frampton, Fuglset, Torzsok-Sonnevend, & Lask, 2011), which would be consistent with the difficulties in disgust processing exhibited by AN participants in this study.

In addition to recognition accuracy, the study investigated response bias in AN. Results showed evidence of response bias towards anger in less ambiguous facial expressions (i.e. at a 90% of proportion level) but not in more ambiguous expressions. Attentional and interpretation bias may provide an explanation for this finding. There is evidence of attentional bias towards angry and rejecting faces in people with AN (Cardi *et al.*, 2013; Harrison, Sullivan, *et al.*, 2010); thus, this group of participants could have paid more attention to slight signs of anger, as those showed in pictures portraying anger at 10% proportion level, increasing the chances of misinterpreting them as angry faces. In addition, misinterpretation of disgust as anger could be related to a specific interpretation bias. AN is highly comorbid with social phobia (Swinbourne *et al.*, 2012), and both attentional and interpretation biases towards threatening stimuli have been described in people with social anxiety (Van Bockstaele *et al.*, 2014). Future studies may explore the role of attention and interpretation bias in emotion recognition in AN.

It could be speculated that a bias towards anger might be the mechanism underlying the misclassification of disgust as anger, shown by AN participants in this study. It has been proposed that in AN, feelings of anger are directed into the body in the form of disgust towards oneself and that these emotions are usually hidden due to the fear of being rejected by others (Fox *et al.*, 2013). This link among the experience of anger, disgust, and rejection in AN might generalise to the process of recognising these emotions in others, as there is evidence that the same brain regions implicated in experiencing emotions are involved in interpreting emotion from facial signals (Calder & Young, 2005). Thus, if the experience of anger, disgust, and rejection are usually linked to each other in people with AN, it may be that faces portraying disgust were experienced by people with AN as rejecting and thus were interpreted as 'angry'. The fact that in our study the bias towards anger was only present when facial expressions were less ambiguous might be explained because more ambiguous faces did not depict disgust clearly, and may have been experienced as less rejecting by AN participants and thus were not interpreted as 'angry' faces. Further studies are needed to test this hypothesis.

Another explanation for the misclassification of disgust as anger in participants with AN may be related to morphological similarities in both facial expressions. Facial expressions of both, disgust and anger, usually involve similar muscular actions in the upper part of the face (such as brow lowering) (Gery, Miljkovitch, Berthoz, & Soussignan, 2009). Some participants with AN, who

have a tendency to focus on details in detriment of the bigger picture (Lang, Lopez, Stahl, Tchanturia, & Treasure, 2014), could have focused on this part of the face, confusing the emotions. Future studies using eye tracking would be needed to test this hypothesis.

Other than the difficulties in disgust recognition and the response bias towards anger, there were no other differences between participants with AN and HC in this study. This may suggest that the difficulties in emotion recognition exhibited by people with AN are minimal. Alternatively, characteristics of the emotion recognition task used in this study could explain the lack of major differences between the groups. Specifically, the negative skewness of the data could indicate a ceiling effect, suggesting that the task was too simple to detect differences between the groups.

A secondary objective of the study was to explore the role of illness severity: BMI, length of illness, depression, obsessive-compulsive symptoms, medications, and alexithymia on poor facial emotion recognition in AN. Results indicated that none of these clinical characteristics was associated with poor disgust recognition. These findings are not in line with previous evidence suggesting that these characteristics were linked to poor emotion recognition in AN (Castro *et al.*, 2010; Jansch *et al.*, 2009; Lule *et al.*, 2014; Zonneville-Bender *et al.*, 2002), and particularly, the lack of association with alexithymia provides no support for the idea that difficulties in emotion recognition in AN are due to alexithymia (Brewer *et al.*, 2015).

The study findings have relevant clinical implications. On the one hand, the findings on emotion accuracy may suggest that the difficulties in emotion recognition are minimal in AN and might not require specific focus during treatment. On the other hand, the bias towards anger found in AN, along with previous evidence of bias towards angry and rejecting faces (Cardi *et al.*, 2013; Harrison, Sullivan, *et al.*, 2010; Harrison, Tchanturia, *et al.*, 2010), might need more attention in treatment adaptations, as it could lead to social difficulties in AN. Studies have shown that AN patients have difficulties in social functioning (Harrison, Mountford, & Tchanturia, 2014; Tchanturia *et al.*, 2013), establishing friendships (Doris, Westwood, Mandy, & Tchanturia, 2014), and have lower emotional intelligence, relative to IQ matched controls (Hambrook, Brown, & Tchanturia, 2012). Moreover, it has been proposed that problems in social and emotional processing might maintain the eating pathology (Treasure & Schmidt, 2013). Thus, the study findings highlight the need to address the misinterpretation of facial cues as a sign of anger, and its possible link to feelings of rejection, in the treatment of women with AN.

The study has some strengths, when compared to previous literature investigating emotion recognition in AN. One of them is a comparably large sample size. Another strength is, the use of a novel task, with ambiguous blended facial expressions of emotions. It is thought that ambiguous stimuli may be more representative of real-life social contexts (Jhung *et al.*, 2010); thus, this task has more ecological validity than those used in previous studies. In addition, the study adds to the literature on emotion recognition, by not only assessing recognition accuracy but also response bias, providing a more complete picture of the ability to recognise emotions in AN. Finally, another strength of the study is the

evaluation of clinical characteristics that had shown to be linked to poor emotion recognition in previous studies in AN.

## Limitations

One of the shortcomings of this study was the use of nonparametric analysis, which prevented from addressing the influence of confounders in emotion recognition. In addition, it needs to be noted that the study was conducted in women, and its findings do not necessarily apply to men with AN. There is evidence of differences in emotion processing in women and men (Hall & Matsumoto, 2004). Therefore, future studies need to explore

emotion recognition in men with AN. Finally, another limitation of the study is that the sample size for the AN group was too small to conduct subgroup analyses for AN subtypes.

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## **CHAPTER 3**

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### **STUDY 3.2. EXPLORING EMOTION RECOGNITION IN ADULTS AND ADOLESCENTS WITH ANOREXIA NERVOSA USING A BODY MOTION PARADIGM**

## **EXPLORING EMOTION RECOGNITION IN ADULTS AND ADOLESCENTS WITH ANOREXIA NERVOSA USING A BODY MOTION PARADIGM**

Body language constitutes a relevant part of nonverbal communication (App, McIntosh, Reed, & Hertenstein, 2011). Alike the face, body movements can convey information about people's emotional states (Keltner & Lerner, 2010).

This study investigated the ability to recognise emotions in body movements, in women with AN, compared with HC.

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## RESEARCH ARTICLE

# Exploring Emotion Recognition in Adults and Adolescents with Anorexia Nervosa Using a Body Motion Paradigm

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## Abstract

**Objective:** There is consistent evidence of difficulties in social cognition in adults with anorexia nervosa (AN), but less is known about adolescents. The aim of this study was to investigate the ability to recognise emotion expressed in body movement in adults and adolescents with AN.

**Method:** One hundred and ninety-three females participated in the study (AN = 97: 61 adults and 36 adolescents). The performance of participants with AN on a body emotion recognition task was compared to age-matched healthy controls (HC = 96).

**Results:** AN participants were significantly worse than HC recognising sadness, with adolescent AN participants showing worse performance overall. There were no difficulties in the recognition of other emotions.

**Discussion:** The results partially support previous studies and the literature on facial emotion recognition, showing poorer recognition of sadness in AN. The results also suggest that difficulties in emotion recognition through body movements may be more subtle than other socio-emotional difficulties observed in AN. Copyright © 2015 John Wiley & Sons, Ltd and Eating Disorders Association.

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## Keywords

Emotion recognition; anorexia nervosa; eating disorders; point light; body motion

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Adults with eating disorders (EDs), and particularly with anorexia nervosa (AN), demonstrate difficulties in social cognition (Caglar-Nazali et al., 2014; Oldershaw, Hambrook, et al., 2011), exhibiting problems in emotional intelligence (Hambrook, Brown, & Tchanturia, 2012), high levels of social anhedonia (Tchanturia et al., 2012), reduced emotion expression (Claes et al., 2012; Davies, Schmidt, Stahl, & Tchanturia, 2011), and poor social functioning (Harrison, Mountford, & Tchanturia, 2014; Tchanturia, Hambrook, et al., 2013) compared to healthy controls (HC). Several theories have proposed that socio-emotional difficulties contribute to the development and/or maintenance of the ED (Arcelus, Haslam, Farrow, & Meyer, 2013; Fox & Power, 2009; Treasure & Schmidt, 2013; Wildes, Ringham, & Marcus, 2010), but further understanding of the mechanisms involved in these difficulties is needed in order to design effective interventions.

An important aspect of social and emotional processing is the visual perception of emotions, including the exchange of information through facial expression, eye gaze, and body movement

(Frith & Frith, 2007). Some of the mechanisms underlying the difficulties exhibited by people with AN may be related to the way in which individuals with AN interpret visually mediated social messages, intentions, and emotions. For example, research has shown attentional biases in individuals with AN towards angry, sad and rejecting faces (Aspen, Darcy, & Lock, 2013; Cardi, Di Matteo, Corfield, & Treasure, 2013; Cserjesi, Vermeulen, Lenard, & Luminet, 2011; Harrison, Sullivan, Tchanturia, & Treasure, 2010), hypervigilance to threat-related cues (McFillin et al., 2012), and avoidance of accepting faces (Cardi et al., 2013).

A majority of studies examining the ability to infer emotional states in others (i.e. emotional Theory of Mind) using the Reading the Mind in the Eyes task (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001) in individuals with EDs (13 in total) have demonstrated that participants with AN are less accurate at identifying emotional states in people's eyes, compared to HC (Tchanturia, Dapelo, Harrison, & Hambrook, 2015). However, findings from studies examining emotion recognition from faces have been more inconsistent (Tchanturia et al., 2015).



Currently, there is a distinct lack of research investigating socio-emotional processing in adolescents with AN. As adolescence is a critical time for social-cognitive development (Blakemore, 2012), social emotional ability at this time period is of particular relevance in understanding the consequences of this disorder. Although limited, the available literature suggests that adolescents with AN may display similar socio-emotional difficulties as adults with AN. A series of studies by Zonnevillje-Bender, van Goozen, Cohen-Kettenis, van Elburg, and van Engeland (2002) and Zonnevillje-Bender et al. (2004) suggested that adolescents with AN showed higher levels of alexithymia, as well as performing significantly worse on experimental measures of facial emotion recognition, compared to matched HCs (Zonnevillje-Bender et al., 2002), along with a comparable poor performance to adult AN participants (Zonnevillje-Bender et al., 2004). Lule et al. (2014) also found a decreased ability to recognise disgust in adolescents with AN. There is also preliminary evidence of reduced facial emotion expression in adolescents with AN (Rhind, Mandy, Treasure, & Tchanturia, 2014). Albeit limited, the available data suggests that further investigation of social cognition in adolescents with AN is warranted.

Facial emotion recognition and expression are only part of nonverbal communication, another important aspect being body language (App, McIntosh, Reed, & Hertenstein, 2011). In fact, it has been proposed that body language can communicate both the emotion and the action tendency associated with the emotion (e.g. fear, therefore escape) (de Gelder, 2006; Demeijer, 1989), and there is evidence that the same brain regions that are known to be involved in the perception of facial emotion expression and behaviour are also involved in the processing of emotional body language (de Gelder, 2006). It has been demonstrated that specific emotional states can be inferred by observing particular body movements (Atkinson, Dittrich, Gemmell, & Young, 2004; Demeijer, 1989; Heberlein, Adolphs, Tranel, & Damasio, 2004), and there is evidence that certain patterns of body movements may be specific to certain emotions (Wallbott, 1998). However, in contrast to the large amount of studies looking at facial emotion recognition, emotion recognition from body motion has received little attention in ED.

Point-light walker (PLW) procedures (Heberlein et al., 2004) have been used to assess recognition of emotion expressed through body movements in different clinical populations. For example, problems with emotion recognition have been consistently demonstrated in the schizophrenia literature when using PLW (Brittain, Ffytche, & Surguladze, 2012; Couture et al., 2010), and similar results have been described for individuals with autistic spectrum disorders (Hubert et al., 2007; Nackaerts et al., 2012). Given the evidence of the high prevalence of autistic traits in people with AN (Baron-Cohen et al., 2013; Gillberg, 1983; Tchanturia, Smith, et al., 2013; Treasure, 2013; Zucker et al., 2007), some difficulties in this ability are to be expected.

To our knowledge, only one study has explored the ability to recognise emotions from body motion in individuals with AN using PLW. Zucker et al. (2013) found that, compared with HC and weight restored participants, individuals with current AN were less accurate at identifying sadness, and more consistent than HC in recognising anger. In this study, weight restored participants showed similar performance to that of the HC (Zucker et al., 2013).

The current study aims to further build on these findings by first, investigating emotion recognition through body motion in a large sample of participants with AN using the PLW procedure. Second, we aim to investigate developmental differences in emotion recognition abilities in AN by comparing the performance of adults and adolescents.

## Materials and methods

### Participants

Participants were 193 females: 97 (61 adults; 36 adolescents) with AN and 96 HC (69 adults; 27 adolescents), ranging in age from 11 to 55 years. The AN participants were recruited from Specialist Eating Disorder clinics and the local community. AN participants received a DSM-5 diagnosis of AN by using the Eating Disorder module of the Structured Clinical Interview for DSM-IV-TR Axis I Disorders (SCID-I) (First, Gibbon, Spitzer, & Williams, 2002). Measures of height and weight were also routinely collected. The inclusion criteria for AN participants older than 18 years of age was a BMI of less than 18.5. For AN participants younger than 18 years of age percentage ideal body weight (%IBW) calculations were made. Ideal body weight measurements indicate the percentage of the individual ideal body weight for their height and age. Participants with a %IBW of less than 90 were included in this study.

HC participants were recruited from the university and local community. Absence of ED symptoms in HC was evaluated using the ED module of the SCID and the Eating Disorder Examination Questionnaire (EDE-Q), along with measures of height and weight. The same BMI threshold was applied, this time, BMI being higher than 18.5 for those over 18 years old (adults) and the %IBW over 90 for those of under 18 years (adolescents). HC and AN sample did not differ significantly in age.

### Measures

#### Structured clinical interview for DSM-IV-TR Axis I Disorders; SCID-I: (First et al., 2002)

The SCID is a semi-structured clinical interview aimed to assess axis I disorders according to the DSM-IV (American Psychiatric Association, 2000). In this study, the ED module (i.e. module H) was used to assess the presence and history of ED. In order to update the interview to DSM-5 criteria, criterion D (i.e. amenorrhea) was not required for AN diagnosis, and the frequency for binges and purges was reduced to once a week to assess the presence of bulimia nervosa in HC.

#### Body mass index (BMI—kg/m<sup>2</sup>) for adult and % ideal body weight (%IBW) for adolescents

BMI and %IBW were calculated based on measurements taken during the testing session.

#### Eating Disorder Examination Questionnaire; EDE-Q: (Fairburn & Beglin, 1994)

The EDE-Q is a 36-item self-report measure that assesses cognitions and behavioural features of ED. In the current study, internal consistency for EDE-Q scales ranged from  $\alpha = 0.77$  to  $\alpha = 0.97$ .



### Hospital Anxiety and Depression Scale; HADS: (Zigmond & Snaith, 1983)

The HADS is a 14-item self-report questionnaire developed to assess anxiety and depression among patients of non-psychiatric clinics and shown to have good validity and reliability (Bjelland, Dahl, Haug, & Neckelmann, 2002). Internal consistency for the anxiety scale was  $\alpha = 0.88$ , and for the depression scale was  $\alpha = 0.83$ .

### Autism Quotient; AQ-10: (Allison, Auyeung, & Baron-Cohen, 2012)

The AQ-10 is a shorter version of the original Autism Quotient (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001) and has been used in ED (Tchanturia, Smith, et al., 2013). A cut-off of 6 has been established to indicate clinical severity of autistic features. In this study, internal consistency was  $\alpha = 0.64$ .

### Emotion recognition from body movement. Point-light walkers task (PLW)

Originally created by Johansson (1973) to investigate human motion. It was then adapted to explore human ability to infer emotional states expressed through bodily motion (Heberlein et al., 2004). The present study employed the same methodology developed in previous studies with video clips of 40 point-light walkers (Atkinson, Heberlein, & Adolphs, 2007). For the development of this task, actors were filmed walking from left to right, whilst portraying one of four emotions (anger, fear, happiness, or sadness) or an emotionally neutral state. The actors were filmed in the dark and had small lights attached to their wrists, ankles, knees, elbows, outer hips, waist, outer shoulders, and head. Thus, the stimuli appeared as white dots on a dark background (Atkinson et al., 2004).

There were 40 trials (4 emotions  $\times$  8 clips + 8 neutral clips) and five different randomised running orders were used. Participants rated which emotion was being portrayed from the five alternative forced-choice words (angry, afraid, happy, sad, or neutral) presented on a card. Five practice clips were used to explain the task.

A proportional correct scoring method, previously used with stimuli of this type, was employed to score participant's answers (Heberlein et al., 2004). In a pilot study, 15 'reference' HC participants rated the emotional clips in the way described above, with the exception that there were no 'neutral' clips and no 'neutral' answer choice (i.e. 32 clips). Percentages were calculated for the amount of times each stimulus was labelled as a particular emotion by the reference group. These percentages then formed the basis of the partial correctness scoring for the main study. For example, if a clip was labelled as 'happy' by 70% of the reference group, 'angry' by 20% of the reference group, and 'sad' by 10% of the reference group, then if a participant in the main study labelled the same clip as 'happy' they would achieve the highest score of 1.0 (0.7/0.7), if they labelled it as 'angry' they would score 0.28 (0.2/0.7), and if they labelled it as 'sad' they would score 0.14 (0.1/0.7). All other answers would receive a score of 0. In the main study, the total score for each emotion corresponds to the sum of the scores obtained by the participant on each of the eight clips that represent the emotion (i.e. the maximum score is 8 for each emotion category). This scoring method accepts that a certain

degree of variability in the interpretation of emotions from body movements is common, for example a body movement can be perceived as both sad and fearful (Heberlein et al., 2004).

### Procedure

Participants attended one session for the study. After completion of BMI measures and the PLW task they filled self-report questionnaires. The study was approved by the NHS Research Ethics Committee, reference number 13/LO/0201 and 12/LO/2015. Informed consent was obtained from all participants.

### Statistical analysis

Data were analysed using the statistical software STATA 12.0 © (StataCorp LP). Visual inspection of histograms revealed that the data for each of the emotion variables was negatively skewed. Standard transformations were not able to normalize the data, and further inspection revealed that the distributions differed between the AN group and the HC group in terms of shape and scale (variability), meaning that the data did not fulfil the assumptions of nonparametric tests (e.g. Mann Whitney *U* test). We therefore analysed the data using median regression (more generally known as quantile regression (Cade & Noon, 2003; Koenker, 2005)), which is a more robust alternative to linear regression and suitable for modelling skewed data. Standard linear regression estimates the relationship between mean of a response distribution and a set of independent or predictor variables; whereas the median regression models the relationship between median of a response distribution and a set of predictor variables. Group comparison can be made in a median regression by including a binary group indicator (in this study, 0 = HC, 1 = AN) as independent variable in the regression model. The regression coefficient for group represents the differences in medians between groups.

For each emotion variable, a median regression was performed to estimate and test for differences in the medians between the AN and HC groups. The effects of group (i.e. the median differences) were adjusted for the effect of age, %IBW, BMI, anxiety, depression, and autistic traits by including them as covariates in the median regression models. Each of the potential confounding variables was tested individually in a separate median regression model. The variables that were found to be individually associated with the outcome variable at a *p*-value level less than 0.05 were included in the adjusted model described above.

Differences between the total AN group and HC group were explored first, with a subsidiary analysis investigating the AN sample split into adults and adolescents.

### Results

Table 1 shows the demographic information of the total AN and HC groups. As expected, there was a significant difference between the groups with regard to BMI and clinical characteristics, such as eating disorders symptoms, anxiety, depression, and autistic traits.

### Group comparisons for each emotion

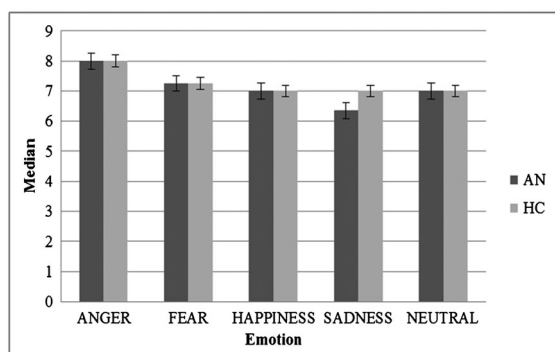
Figure 1 shows the median for each emotion for both the AN and the HC groups. Median regressions are shown in Table 2.

**Table 1** Participant demographics and clinical measures

	AN				HC				Cohen's <i>d</i>
	<i>N</i>	Min	Max	Mean (SD)	<i>N</i>	Min	Max	Mean (SD)	
Age	97	11.00	47.00	22.40 (8.32)	96	11.00	53.00	23.72 (9.80)	0.15
BMI * (adults only)	61	11.60	18.40	15.44 (1.68)	69	18.74	28.40	22.34 (2.42)	3.30
W4H * (adolescents only)	36	61.07	89.65	80.65 (6.69)	27	90.18	128.82	100.62 (9.95)	2.46
EDE-Q Rest *	97	0.00	6.00	3.56 (1.80)	96	0.00	4.40	0.81 (0.94)	1.92
EDE-Q Eat C *	97	0.00	6.00	3.40 (1.46)	96	0.00	2.40	0.31 (0.47)	2.86
EDE-Q Sh C *	97	0.13	6.00	4.45 (1.56)	96	0.00	5.13	1.33 (1.06)	2.35
EDE-Q Wt C *	97	0.20	6.00	3.74 (1.62)	96	0.00	4.20	0.96 (0.94)	2.11
EDE-Q Global *	97	0.19	6.00	3.79 (1.44)	96	0.00	3.83	0.85 (0.76)	2.56
Age of Onset	97	8.00	37.00	16.40 (5.51)					
Length of Illness (years)	97	0.00	37.00	6.20 (7.22)					
HADS-A *	97	0.00	21.00	11.20 (5.08)	96	0.00	9.00	4.05 (2.60)	1.78
HADS-D *	97	0.00	21.00	11.67 (4.90)	96	0.00	9.00	3.63 (2.04)	2.15
AQ-10 *	97	0.00	9.00	3.92 (2.13)	96	0.00	5.00	1.87 (1.34)	1.16

BMI = body mass index; W4H = percentage weight for height, EDE-Q Rest = Eating Disorder Examination Questionnaire Restraint; EDE-Q Eat C = Eating Disorder Examination Questionnaire Eating Concerns; EDE-Q Sh C = Eating Disorder Examination Questionnaire Shape concerns; EDE-Q Wt C = Eating Disorder Examination Questionnaire Weight Concerns; EDE-Q Global = Eating Disorder Examination Questionnaire Global Score; HADS-A = Hospital Anxiety and Depression Scale Anxiety subscale; HADS-D = Hospital Anxiety and Depression Scale Depression subscale; AQ-10 = Autism Quotient 10.

(\*) Mean difference is statistically significant ( $p < 0.01$ ).

**Figure 1** Medians and standard errors for each emotion for AN and HC groups

### Neutral

There were no significant differences between AN and HC groups on neutral clips (difference in medians = 0.00,  $p = 1.00$ ).

### Anger

Because of lack of between group data variability, it was not possible to compute median regression for the anger clips. Visual inspection of the medians for the AN group and HC group suggested that there were no differences between groups (AN median = 8.00, HC median = 8.00). Further inspection of the shape of the distribution of this variable indicated that it was similar for both groups (AN and HC); therefore, Mann Whitney *U* test was carried out. The test confirmed that there were no significant differences between AN and HC ( $U(191) = 5,071.00$ ,  $p = 0.23$ ).

**Table 2** Median regression for each emotion

Emotion	Regression coef. for group (AN vs. HC)	SE (coef.)	<i>p</i> -Value	95% CI
Neutral	0.00	0.21	1.00	(−0.42, 0.42)
Fear	0.00	0.14	1.00	(−0.27, 0.27)
Happiness	0.00	0.20	1.00	(−0.40, 0.40)
Sadness*	−0.64	0.25	0.01	(−1.14, −0.14)

Regression coef. = coefficients represent the estimated differences in medians between AN and HC groups; AN = anorexia nervosa; HC = healthy controls; SE = standard error; CI = confidence interval.

(\*) Regression is statistically significant ( $p < 0.05$ ).

### Fear

There were no differences between the AN and HC groups in recognising fear (difference in medians = 0.00,  $p = 1.00$ ).

### Happiness

There were no significant differences recognising happiness between AN and HC groups (difference in medians = 0.00,  $p = 1.00$ ).

### Sadness

There was a significant difference between the medians of AN and HC groups, with the AN group being less accurate at recognising sadness (difference in median = −0.64,  $p = 0.012$ ). Group, age, and %IBW were significant independent predictors of the outcome. However, when added together to the median regression model, %IBW lost significance. Group and age remained significant predictors, with younger participants exhibiting worse

performance (difference in median =  $-0.58$ ,  $p = 0.028$ ). Together they predicted 4.19% of the variance.

The AN participants who did not correctly recognise and label the sadness stimulus, most commonly misinterpreted the clips as neutral (mean percentage of participants for the 8 sad clips = 17.5%), followed by anger (mean percentage of participants = 6.7%), happiness (mean percentage of participants = 2.7%), and then fear (mean percentage of participants = 2.1%). Further inspection of the data indicated that the results were not because of the systematic misinterpretation of one specific clip, but all the sad clips had been misinterpreted by at least some AN participants.

### Adult versus adolescent analysis

A further analysis of the sadness emotion, which had shown difficulties in the total AN group with age as significant factor, was carried out by splitting the sample into adults ( $\geq 18$  years old) and adolescents ( $< 18$  years old). Table 3 describes means and medians for each group. This new variable was included as a covariate in the median regression along with the interaction effect of the clinical group (i.e. AN or HC) and the age group (i.e. adult or adolescent). The interaction was statistically significant (difference in median =  $0.089$ ,  $p = 0.001$ ) meaning that AN versus HC group difference varied between the adult and adolescent group. Adolescents with AN exhibited worse performance than the rest of the participants.

## Discussion

The aim of the study was to explore emotion recognition through body movements using a group of adolescents and adults with AN. The findings demonstrated that overall, there was poorer performance in recognising sadness in the AN group compared to HC. There was no evidence of difficulties in the recognition of fear, anger, and happiness in body motion stimuli.

Our results are in agreement with previous findings from Zucker et al. (2013) who reported difficulties in the recognition of sadness in AN participants using point-light walkers (PLW). In addition, our findings are consistent with the previous literature evaluating facial emotion recognition in AN. For example, Kucharska-Pietura, Nikolaou, Masiak, and Treasure (2004) reported poorer recognition of sadness in faces in AN, and the same results have been found by Pollatos, Herbert, Schandry, and Gramann (2008), and Castro, Davies, Hale, Surguladze, and

Tchanturia (2010). Taken together, these findings may be suggestive of specific difficulties in the recognition of sadness in AN.

Moreover, a study using electroencephalography along with an emotion recognition task found that the difficulties recognising sadness in AN were associated with an increase in N200 amplitudes, which the authors related to an increase in attentional demands for the classification of sad faces (Pollatos et al., 2008). This would be consistent with studies on attentional bias that report a bias towards sad faces (Cserjesi et al., 2011). It might be that individuals with AN have difficulties processing signs of sadness in faces and body, requiring more attentional resources to interpret these cues, and therefore exhibiting longer reaction times in attentional bias tasks. In this study, response times were not measured, and therefore we are unable to test this hypothesis. However, future studies might provide more insight on the mechanisms explaining the difficulties on sadness recognition in people with AN.

In our study there was a significant interaction between group (AN or HC) and age, whereby younger participants with AN appeared to show poorer recognition of sadness. Further exploration of this interaction indicated that adolescents with AN showed more difficulties in sadness recognition compared to adults. This is the first study to explore emotion recognition through body movement in adolescents with AN, and our findings are consistent with studies on facial emotion recognition that have shown difficulties in adolescents with AN (Zonneville-Bender et al., 2002; Zonneville-Bender et al., 2004). Our results are also consistent with studies on facial emotion recognition in non-clinical populations that have demonstrated a continuum in the process of learning to recognise emotion expression throughout development (Herba & Phillips, 2004). Poorer performance in adolescents with AN could be because of the effects of starvation at a critical period of brain maturation disturbing the normal developmental trajectory of emotion recognition skills. Further studies with children and adolescents with AN utilising fMRI to delineate the neural underpinnings of emotion recognition are needed to confirm this.

Our study findings indicate that AN participants who were poorer at recognising sad clips, often misinterpreted them as neutral. It can be speculated that having difficulties in correctly recognising sadness in others can have negative consequences for social interaction, as it makes it hard to recognise the needs of others and respond appropriately, for example, by showing empathy. The evidence from studies on decision making suggest that sadness elicits compassion and leads to cooperation among people (Polman & Kim, 2013). Thus, having difficulties recognising sadness could have a negative impact on social cooperation. Furthermore, the finding that adolescents with AN were the poorest at recognising sadness highlights the need to support adolescents with AN in their social development, especially because adolescence is a time of rapid social development, where social relationships are particularly salient.

Our findings suggest that difficulties in emotion recognition in AN differ from those described for people with schizophrenia (Brittain et al., 2012; Couture et al., 2010) and autism (Hubert et al., 2007; Nackaerts et al., 2012; Philip et al., 2010). Unlike these clinical groups, individuals with AN do not seem to exhibit a generalised problem with emotion recognition from body motion.

**Table 3** Mean and medians for sadness recognition for AN adults, AN adolescents, HC adults, and HC adolescents

	N	Mean	S.D.	Median
AN adolescents	36	5.45	1.45	5.68
AN adults	61	6.45	1.53	7.00
HC adolescents	27	6.47	1.40	7.00
HC adults	69	6.48	1.42	7.00

N = number of participants in the group; SD = standard deviation; AN = anorexia nervosa; HC = healthy control.

Moreover, in our study, autistic features, as measured by the AQ-10, were not associated with emotion recognition performance in PWL task. One possible explanation for this lack of association could be that although individuals with AN and ASD have similarities in cognitive profiles, there may be distinct differences in the emotional difficulties shown by each group (Oldershaw, Treasure, Hambrook, Tchanturia, & Schmidt, 2011); therefore, although some individuals with AN show elevated levels of autistic traits, they may not meet the clinically defined cut-off for a diagnosis of autism, and this may not translate into the same emotion recognition difficulties that are observed in individuals with a diagnosis of ASD. In addition, the majority of the ASD literature is based on male participants, whereas experimental studies of emotions in ED field are conducted on female participants including the current study. Finally, it is worth noting that in this study, the AQ-10 did not have a satisfactory internal consistency; therefore, results on autism should be interpreted with caution.

The relative subtlety of our findings in comparison to stronger evidence of difficulties in other areas of emotion recognition for those with AN (Caglar-Nazali et al., 2014; Oldershaw, Hambrook, et al., 2011) could suggest that emotion recognition through body movement may be considered a comparative strength in AN. It has been suggested that because body language provides information about both emotional states and their associated intentions, it may be a less ambiguous signal compared to facial emotion expression, and therefore easier to recognise, label, and respond to (de Gelder, 2006).

It should be noted that the study might be limited by the negative skewing of the emotional recognition data for both AN and HC participants, with a proportion of the participants achieving maximum scores. This may suggest a ceiling effect in the case of anger and could explain why an enhanced ability to identify anger in AN was not found in this study. Moreover, even though we used the exact same methodology utilized in previous studies (e.g. Heberlein et al., 2004), the absence of neutral clips and

answer choices in the pilot study, which provided the information for the proportional correct scoring method, might have had an impact on the study results. Additionally, as a majority of AN cases are female, the present study only included female participants. However, given the known gender differences in the recognition of emotions in facial expressions (Hall & Matsumoto, 2004; Thayer & Johnsen, 2000) differences in body emotion recognition between men and women may also be expected, and future studies could be conducted to address this issue.

In summary, this study explored emotion recognition in body motion in a large group of participants with AN, and it is the first to investigate this in adolescents with AN. Its results are important for the field as they replicate previous findings of difficulties in sadness recognition in AN. As the AN group's difficulties were confined to sadness, the results also suggest that difficulties in emotion recognition through body movements may be fairly subtle in comparison to other socio-emotional difficulties observed in this population. This information could be used in the development of future treatments targeting emotional skills. In addition, the greater impairment exhibited by adolescents with AN in this study highlights the importance for future research to continue to focus on the adolescent AN population.<sup>3</sup>

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## **CHAPTER 3**

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### **STUDY 3.3. EMOTION RECOGNITION IN FACES AND BODY MOVEMENTS IN WOMEN WITH BULIMIA NERVOSA**

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## **3.3.1. INTRODUCTION**

Bulimia nervosa (BN) is an eating disorder characterised by recurrent episodes of binge eating followed by inappropriate compensatory behaviours, such as vomiting, laxative misuse, etc. (APA, 2013). It has been proposed that the core symptom of BN, binge eating, is maintained by problems in emotional processing. According to this view, negative affect might trigger episodes of binge eating, which may provide comfort and distraction, regulating negative emotions (Hawkins & Clement, 1984; Stice, 2001). In support of this model, it has been shown that people with BN have difficulties regulating emotions (Lavender et al., 2014) and feel urges to eat in response to negative emotions, often referred as emotional eating (Fioravanti et al., 2014). Moreover, it has been demonstrated that people with BN have high levels of alexithymia, especially experiencing problems when attempting to identify their own emotions (for a review see Nowakowski, McFarlane, & Cassin, 2013).

In addition, people with BN have shown difficulties in socio-emotional functioning that are similar to those with AN, including high levels of social anhedonia (Harrison, Mountford, & Tchanturia, 2014), attentional bias towards angry and rejecting faces (Cardi, Di Matteo, Corfield, & Treasure, 2013; Harrison, Sullivan, Tchanturia, & Treasure, 2010), and avoidance of accepting and compassionate faces (Cardi et al., 2013). However, in contrast to the number of studies investigating emotion recognition in AN (see study 3.1), the ability to recognise emotions in others has received little attention in BN.

A handful of studies have explored emotion recognition in other people's faces in participants with BN. Zonnevijlle-Bender, van Goozen, Cohen-Kettenis, van Elburg, and van

Engeland (2002) conducted a study of emotion recognition in adolescents with ED, including AN and BN, and reported difficulties recognising all emotions. Studies in adults with BN have yielded dissimilar findings, usually reporting difficulties recognising a specific emotion, whilst the ability to identify other emotions is unaltered. For example, two studies have found slight difficulties recognising surprise in BN participants (Kessler, Schwarze, Filipic, Traue, & von Wietersheim, 2006; Legenbauer, Vocks, & Ruddle, 2008), and a study found that BN participants had difficulties recognising anger, misinterpreting it as fear or neutral (Kuhnpast, Gramann, & Pollatos, 2012), but no problems in other emotions.

It has been proposed that properties of the stimuli used in emotion recognition tasks may influence participant's performance (Kuhnpast et al., 2012). Most of the previous studies have used pictures of faces showing prototypical expressions of emotions. Instead, real-life facial expressions are usually ambiguous and may involve blended emotions (Buisine et al., 2006), which can be more challenging to interpret. There is preliminary evidence of poorer performance in subtle displays of emotions in non-clinical participants with disordered eating behaviour (Ridout, Wallis, Autwal, & Sellis, 2012), but the ability to recognise emotions in ambiguous, blended facial expressions in people with BN is still unknown.

In addition to facial expressions, another source of information about people's emotions is body language (App et al., 2011). It has been shown that specific emotional states can be inferred by observing particular body movements (Atkinson, Dittrich, Gemmell, & Young, 2004; Demeijer, 1989; Heberlein, Adolphs, Tranel, & Damasio, 2004), and there is evidence that certain patterns of body movements may be specific to certain emotions (Wallbott, 1998). However, to this date no study has investigated emotion recognition from body motion in people with BN.

The current study aimed to investigate emotion recognition in women with BN by looking at the ability to recognise emotions from facial expressions and from body motion. Since some



socio emotional characteristics of people with BN have shown to be similar to those with AN, we hypothesised that people with BN will exhibit subtle, nonetheless meaningful, difficulties in emotion recognition, similar to those observed in previous studies (Study 3.1 and 3.2).

### **3.3.2. METHODS**

#### **3.3.2.1. Participants**

Sixty-eight adult women participated in the study, 26 with BN and 42 HC (same participants of study 3.1). Participants with BN were included in the study if they met DSM-5 (APA, 2013) criteria for BN, assessed using the ED module of the Structured Clinical Interview for DSM-IV-TR Axis I Disorders (SCID-I) (First, Gibbon, Spitzer, & Williams, 2002). These participants were recruited from specialist ED services, and through advertisement on the Beat website (<http://www.b-eat.co.uk/>). Exclusion criteria for all groups were presence of head injury, autistic spectrum disorders, psychosis, not being fluent in English, or inability to provide informed consent. Participants were compensated for their participation with £10.

At the time of the study, twelve participants were receiving outpatient treatment (46.20%), two were taking part in self-help groups (7.70%), and one was on intensive outpatient treatment (3.80%). The rest were not receiving treatment (n=11; 42.30%).

Seven participants were using psychotropic medication (26.90%). The most common medications were selective serotonin re-uptake inhibitors (SSRI) (n=5). One participant was taking tricyclics along with atypical antipsychotics, and the other participant did not report which medication she was using.

### 3.3.2.2. Measures

3.3.2.2.1. *Body Mass Index (BMI; kg / m<sup>2</sup>)*: This was determined by measuring height and weight of participants on the day of the assessment.

3.3.2.2.2. *Structured Clinical Interview for DSM-IV-TR Axis I Disorders; SCID-I (First et al., 2002)*: The eating disorders module of the SCID-I was used to assess current BN diagnosis and history of ED. The frequency of binge eating and purging behaviour was reduced to once a week for the diagnosis of BN, and amenorrhea was not required for AN diagnosis, in order to adjust the interview to DSM-5 criteria.

3.3.2.2.3. *Eating Disorder Examination Questionnaire; EDE-Q (Fairburn & Beglin, 1994)*: The EDE-Q is a 36-item self-report measure widely used to evaluate eating disorder cognitions and behaviours. The internal consistency for the EDE-Q global score in the current sample was  $\alpha=0.98$ .

3.3.2.2.4. *Hospital Anxiety and Depression Scale; HADS (Zigmond & Snaith, 1983)*: The HADS is a 14-item self-report questionnaire with two subscales that evaluate anxiety and depression. Internal consistencies in the current study were  $\alpha=0.70$  for the anxiety subscale, and  $\alpha=0.75$  for the depression subscale.

3.3.2.2.5. *Toronto Alexithymia Scale- 20; TAS-20 (Bagby, Parker, & Taylor, 1994)*: The TAS-20 is a 20-item, self-report questionnaire used to evaluate alexithymia. Internal consistency in this study was  $\alpha=0.91$ .

#### *3.3.2.2.6. Facial emotion recognition task:*

The facial emotion recognition task used in this study is described in detail in study 3.1 and in chapter 2. Stimuli were pictures of faces depicting expressions of blended emotions taken from the Facial Expressions of Emotion: Stimuli and Test (FEEST) set of morphed facial expressions (Young, Perret, Calder, Sprengelmeyer, & Ekman, 2002). Pictures showed a combination of two emotions in five proportions (i.e., 90:10, 70:30, 50:50, 30:70, and 10:90). Ten combinations were used (i.e., happiness-fear, happiness-sadness, happiness-disgust, happiness-anger, fear-sadness, fear-disgust, fear-anger, sadness-disgust, sadness-anger, and disgust- anger).

There were three blocks of pictures, each of them with 100 pictures presented in a different order, with a five-minute rest interval between each block. The facial expressions were shown on a computer screen, along with five answer choices (afraid, angry, disgusted, happy, or sad). Participants had to select the answer choice that best described the facial expression, in a forced-choice paradigm.

To evaluate emotion recognition accuracy, percentage of correct response was obtained in the same manner described on study 3.1 and chapter 2. In order to obtain response bias scores, the percentage time a participant selected a particular type of ‘incorrect’ response was calculated (e.g., the percentage times a participant identified ‘anger’ on a facial expression that was not showing anger).

#### *3.3.2.2.7. Body motion emotion recognition task. Point-light walkers (PLW):*

The PLW task used in this study is described in detail in study 3.2 and chapter 2. Forty video clips of point-light walkers were used, in which actors were filmed walking from left to right, whilst portraying one of four emotions (anger, fear, happiness, or sadness) or an emotionally neutral state (Atkinson, Heberlein, & Adolphs, 2007). The actors were filmed in the dark and

had small lights attached to their joints. Thus, the stimuli appeared as white dots on a dark background (Atkinson et al., 2004). Participants watched the videos on a computer screen and rated which emotion was being portrayed from the five alternative forced-choice words (angry, afraid, happy, sad, or neutral) presented on a card. Five practice clips were used to explain the task.

To evaluate emotion recognition accuracy, a proportional correct scoring method was employed, using the data from a pilot study (Heberlein et al., 2004). More details on the scoring methods are described in chapter 2. Similar to the facial emotion recognition task, in order to obtain response bias scores, the percentage time a participant incorrectly identified a particular emotion on a clip was calculated.

#### **3.3.2.3. Procedures**

Participants attended one session in which they signed informed consent and all the self-report and experimental measures were carried out. The study was approved by the NHS Research Ethics Committee, reference number 13/LO/0201.

#### **3.3.2.4. Statistical Analysis**

Data were analysed using SPSS version 22. First, distributions were examined to assess normality. In most of the cases, emotion recognition accuracy data were negatively skewed, and response bias data were positively skewed. Transformations in both cases were unsuccessful, thus non-parametric Mann-Whitney U test was used to evaluate differences between BN and HC participants, with Rosenthal's  $r$  effect size for non-parametric test. When data were normally distributed, a 2X5 ANOVA was used to examine the main effects of group, emotion, and group X emotion interaction on emotion recognition accuracy. When the BN participants showed poorer emotion recognition accuracy than the HC group,

Spearman correlations were carried out to explore the association of clinical characteristics such as length of illness, eating disorder features, anxiety, depression, and alexithymia and recognition accuracy. In addition, the BN sample was split into those who were using psychotropic medication and those who were not, with Mann Whitney U test used to test for group differences. Bonferroni correction for multiple testing was applied. For statistically significant results, both uncorrected and corrected  $p$  values are reported (corrected  $p$  values are referred as “ $p_{cor}$ ”).

### **3.3.3. RESULTS**

#### **3.3.3.1. Demographics and Clinical Characteristics**

As shown in table 3.1, there was no significant difference in age and BMI between participants with BN and HC. As expected, the groups differed on clinical characteristics such as eating disorder features, anxiety, depression and alexithymia.

Participants with BN ( $n=26$ ) had an average length of illness of nearly 8 years ( $M=7.73$ ;  $SD=6.50$ ), and 50% of them met criteria for AN diagnosis at some point in the past ( $n=13$ ).

**Table 3.1. Demographics and clinical characteristics**

	BN (n=26)		HC (n=42)		Cohen's <i>d</i>	P- value
	Mean	SD	Mean	SD		
Age (years)	26.42	6.53	26.98	7.55	0.08	0.76
BMI	21.74	2.88	22.53	2.63	0.29	0.25
EDE-Q	3.95	1.29	0.56	0.49	3.9	<0.01
HADS-A	12.08	2.81	5.79	1.96	2.75	<0.01
HADS-D	9.27	3.50	3.74	1.29	2.36	<0.01
TAS-20	55.19	13.48	34.48	6.65	2.14	<0.01

BN= Bulimia Nervosa; HC= Healthy controls; SD= Standard deviation; Cohen's *d*= Cohen's *d* effect size; BMI= Body mass index; EDE-Q= Eating disorders questionnaire global score; HADS-A= Hospital Anxiety and Depression Scale- anxiety scale; HADS-D= Hospital Anxiety and Depression Scale- depression scale; TAS-20= Toronto Alexithymia Scale.

### **3.3.3.2. Face emotion recognition**

Mean percentage accuracy for all emotions are shown in table 3.2.

**Table 3.2. Percentage responses for emotions at 90%, 70%, and 50%**

	BN (n=26)				HC (n=42)			
	Mean	SD	Mdn	IQR	Mean	SD	Mdn	IQR
Anger 90%	84.94	15.37	87.50	25.00	86.71	14.10	91.67	17.71
Disgust 90%	86.38	12.94	89.58	16.67	92.96	11.55	95.83	8.33
Fear 90%	97.28	7.81	100.0	0.00	99.11	2.17	100.0	0.00
Happiness 90%	98.88	4.18	100.0	0.00	98.91	4.02	100.0	0.00
Sadness 90%	97.28	6.23	100.0	1.04	98.31	3.06	100.0	4.17
Anger 70%	75.00	16.91	83.33	25.00	76.39	14.71	81.25	26.04
Disgust 70%	86.86	13.21	91.67	16.67	88.49	13.55	91.67	20.83
Fear 70%	87.66	11.33	89.58	12.50	91.27	5.43	91.67	8.33
Happiness 70%	93.59	5.56	95.83	1.04	92.46	8.55	95.83	4.17
Sadness 70%	80.93	14.15	83.33	13.54	84.13	8.09	87.50	8.33
Anger 50%	32.21	18.77	31.25	37.50	27.98	13.75	25.00	25.00
Disgust 50%	45.19	15.84	37.50	25.00	43.75	14.41	37.50	12.50
Fear 50%	59.13	18.22	62.50	25.00	62.50	12.95	62.50	25.00
Happiness 50%	55.29	20.67	50.00	15.63	52.68	20.39	50.00	28.13
Sadness 50%	31.25	12.87	25.00	12.50	34.52	15.07	37.50	25.00

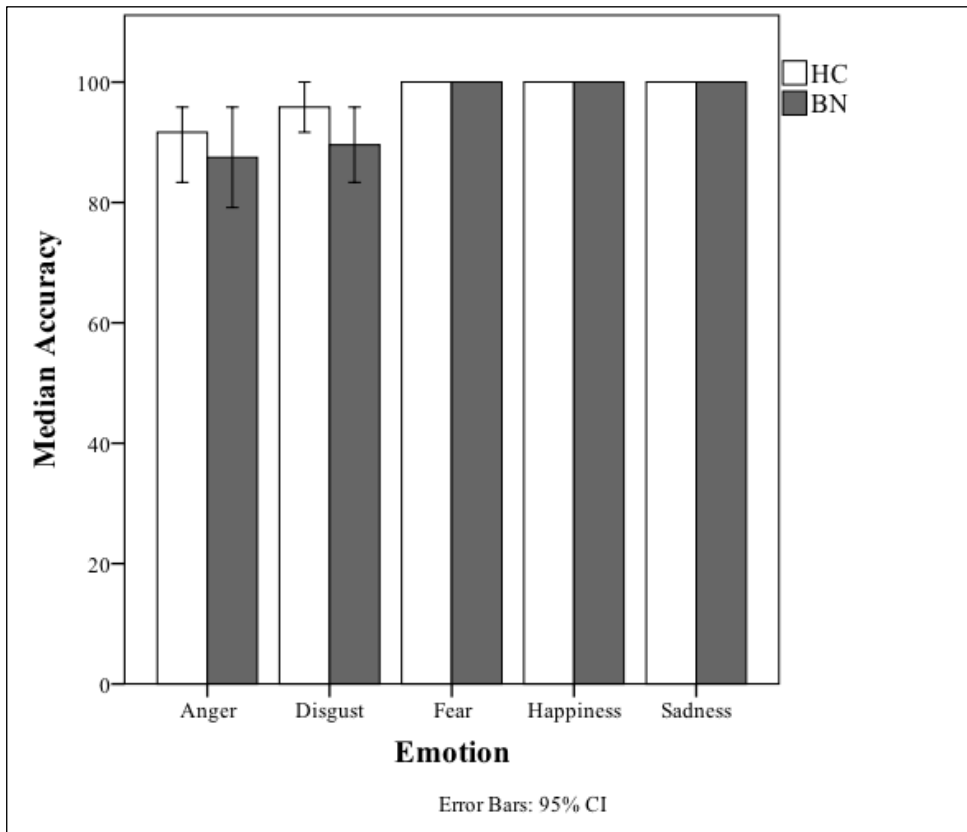
BN= Bulimia nervosa; HC= Healthy controls; SD= Standard deviation; Mdn= Median; IQR= Interquartile range.



### 3.3.3.2.1. Emotion recognition at 90%

Figure 3.1. shows the median percentage accuracy for all emotions at 90% proportion. Results from Mann Whitney U test indicated that participants with BN were significantly less accurate recognising disgust depicted at a proportion of 90% ( $U(66)=330.50$ ;  $p<0.01$ ;  $p_{\text{cor}}<0.05$ ;  $r=-0.34$ ). There were no differences between BN and HC groups in recognition accuracy for all other emotions (Anger:  $U(66)= 511.50$ ;  $p= 0.66$ ; Fear:  $U(66)= 543.50$ ;  $p= 0.96$ ; Happiness:  $U(66)= 560.00$ ;  $p= 0.76$ ; Sadness:  $U(66)= 559.00$ ;  $p=0.83$ ).

**Figure 3.1. Median accuracy for emotions at 90%**



BN= Bulimia nervosa; HC= Healthy controls; CI=Confidence Interval.

Further examination of the responses through a confusability matrix showed that most of the BN participants who did not recognise disgust misinterpreted it as anger (Table 3.3). Finally, the associations between clinical characteristics and disgust recognition were explored in the BN group (n=26). Results from Spearman correlation indicated no association between length of illness, eating disorder features, anxiety, depression, alexithymia, and disgust recognition (Length of illness:  $r_s=-0.17$ ;  $p=0.42$ ; EDE-Q:  $r_s=-0.22$ ;  $p=0.28$ ; HADS-A:  $r_s=-0.15$ ;  $p=0.46$ ; HADS-D:  $r_s=-0.04$ ;  $p=0.89$ ; TAS-20:  $r_s=-0.17$   $p=0.4$ ). Moreover, BN participants who were taking psychotropic medications did not differ from those unmedicated on disgust recognition ( $U(24)= 66.00$ ;  $p= 1.00$ ).

**Table 3.3. Confusability matrix for emotions at 90%**

BN Response	Emotion portrayed (i.e. correct response)				
	Anger	Disgust	Fear	Happiness	Sadness
Anger	<b>84.9%</b>	12.0%	0.8%	0.3%	0.8%
Disgust	8.2%	<b>86.4%</b>	1.9%	0.5%	0.8%
Fear	6.6%	0.0%	<b>97.3%</b>	0.2%	1.1%
Happiness	0.0%	0.0%	0.0%	<b>98.9%</b>	0.0%
Sadness	0.3%	1.6%	0.0%	0.2%	<b>97.3%</b>
Total	100.0%	100.0%	100.0%	100.0%	100.0%
HC Response	Emotion portrayed (i.e. correct response)				
	Anger	Disgust	Fear	Happiness	Sadness
Anger	<b>86.7%</b>	5.9%	0.4%	0.2%	0.4%
Disgust	3.6%	<b>93.0%</b>	0.4%	0.1%	0.3%
Fear	9.4%	0.2%	<b>99.1%</b>	0.2%	1.0%
Happiness	0.0%	0.0%	0.0%	<b>98.9%</b>	0.0%
Sadness	0.3%	1.0%	0.1%	0.6%	<b>98.3%</b>
Total	100.0%	100.0%	100.0%	100.0%	100.0%

BN= Bulimia nervosa; HC= Healthy controls. Percentages in bold represent the percentage of correct response.

Mean response bias for all emotions are shown in table 3.4. The BN group had a higher preference to interpret non-angry faces as anger, when compared to HC ( $U(66)=747.00$ ;  $p<0.01$ ;  $p_{\text{cor}}<0.05$ ;  $r=0.32$ ), indicating a response bias towards anger. BN participants also exhibited a higher preference to interpret non-disgusted faces as disgust, but the difference was no longer significant after correcting for multiple testing ( $U(66)=702.50$ ;  $p<0.05$ ;  $p_{\text{cor}}=0.19$ ;  $r=0.25$ ). There was no evidence of response bias for other emotions. (Fear:  $U(66)=455.50$ ;  $p=0.24$ ; Happiness:  $U(66)=546.00$ ;  $p=1.00$ ; Sadness:  $U(66)=596.50$ ;  $p=0.42$ ).

**Table 3.4. Percentage response bias for emotions at 90%, 70%, and 50%**

	BN (n=26)				HC (n=42)			
	Mean	SD	Mdn	IQR	Mean	SD	Mdn	IQR
Anger 90%	3.49	4.24	2.08	4.17	1.71	2.77	1.04	2.08
Disgust 90%	2.84	3.58	1.56	4.43	1.09	1.61	0.52	1.04
Fear 90%	1.96	72.94	1.04	2.34	2.70	3.15	2.08	3.39
Happiness 90%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sadness 90%	0.52	0.85	0.00	1.04	0.50	1.18	0.00	0.26
Anger 70%	5.57	3.24	4.17	5.21	4.49	3.00	4.17	4.17
Disgust 70%	4.97	5.26	3.65	6.51	2.51	2.25	2.08	2.34
Fear 70%	5.97	4.41	4.69	4.69	6.67	3.45	6.25	4.17
Happiness 70%	0.88	1.17	0.00	2.08	1.07	1.43	0.00	2.08
Sadness 70%	1.60	2.17	1.04	1.08	2.08	2.93	1.04	2.08
Anger 50%	6.73	5.28	8.33	8.33	6.75	5.28	8.33	8.33
Disgust 50%	2.56	4.58	0.00	8.33	2.78	6.29	0.00	0.00
Fear 50%	6.73	6.25	8.33	8.33	7.54	7.98	8.33	16.67
Happiness 50%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sadness 50%	1.92	4.89	0.00	0.00	1.98	4.44	0.00	0.00

BN= Bulimia nervosa; HC= Healthy controls; SD= Standard deviation; Mdn= Median; IQR= Interquartile range.

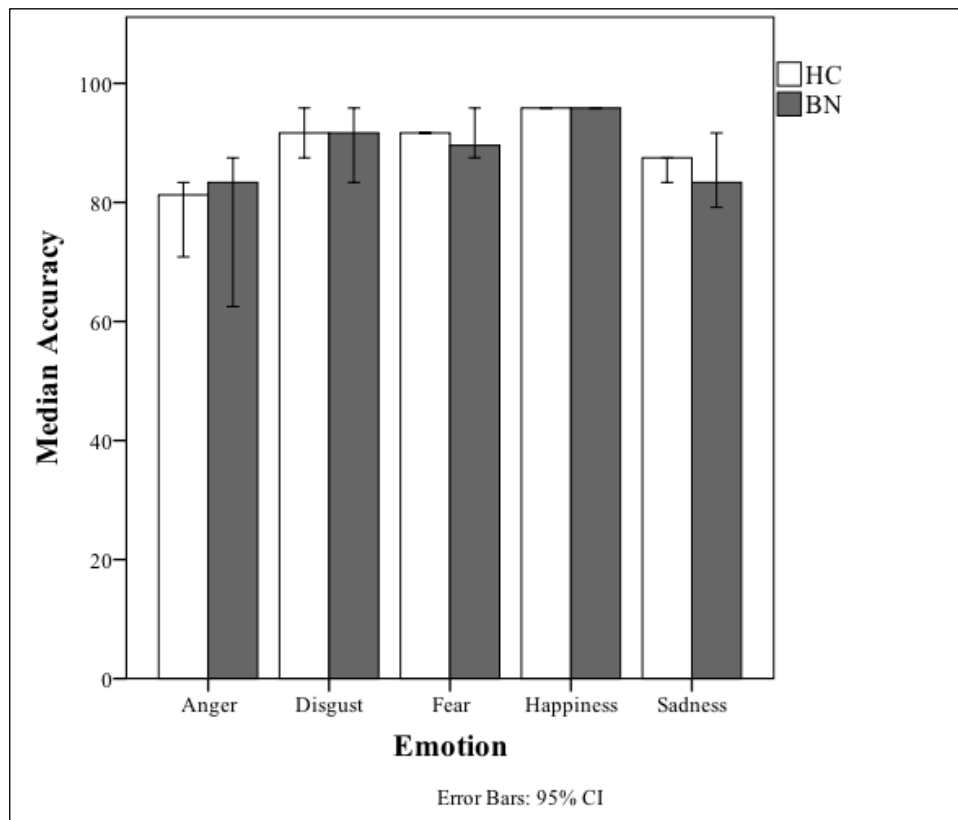
#### 3.3.3.2.2. *Emotion recognition at 70%*

Median percentage accuracy for all emotions at 70% proportion is shown in figure 3.2.

Results from Mann Whitney U test showed no differences between participants with BN and HC in recognition accuracy for emotions depicted at 70% proportion (Anger:  $U(66)=551.50$ ;  $p=0.94$ ; Disgust:  $U(66)=473.50$ ;  $p=0.35$ ; Fear:  $U(66)=474.00$ ;  $p=0.35$ ; Happiness:  $U(66)=576.00$ ;  $p=0.63$ ; Sadness:  $U(66)=521.00$ ;  $p=0.75$ ).

There was no evidence of response bias in these emotions (Anger:  $U(66)=662.50$ ;  $p=0.14$ ; Disgust:  $U(66)=672.00$ ;  $p=0.11$ ; Fear:  $U(66)=436.00$ ;  $p=0.16$ ; Happiness:  $U(66)=517.50$ ;  $p=0.69$ ; Sadness:  $U(66)=502.50$ ;  $p=0.57$ ).

**Figure 3.2. Median accuracy for emotions at 70%**



BN= Bulimia nervosa; HC= Healthy controls; CI=Confidence Interval.

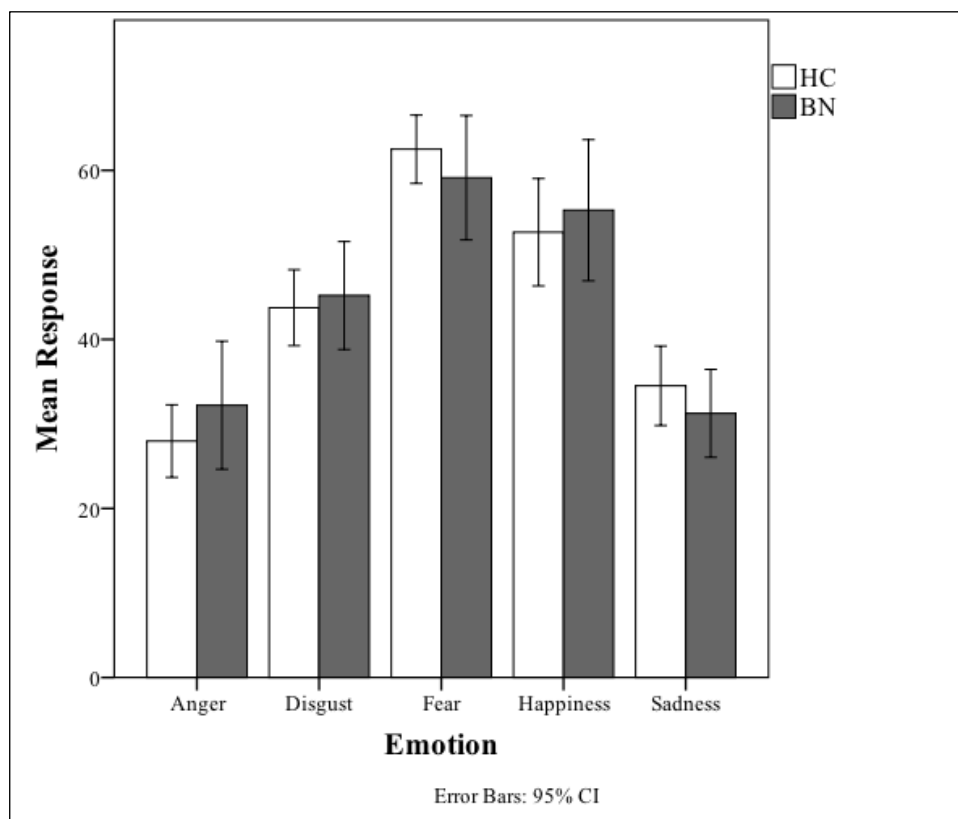


#### 3.3.3.2.3. *Emotion recognition at 50%*

Mean percentage response for all emotions at 50% proportion is shown in figure 3.3. Since data were normally distributed, factorial ANOVA was carried out to analyse recognition accuracy, with two groups (i.e., BN and HC) and five emotions (i.e., anger, disgust, fear, happiness, and sadness) as factors. Results indicated that there was no significant main effect of group on the percentage response, meaning that BN participants did not differ from HC ( $F(1,340)=0.03$ ,  $p=0.86$ ). There was a main effect of emotion, indicating that not all emotions were recognised equally ( $F(4,340)=42.21$ ,  $p<0.01$ ). Tukey post-hoc test showed a trend for fear and happiness to be selected more often by all participants, followed by disgust, and lastly by sadness and anger ( $p=0.06$ ). Finally, the effect of the groupXemotion interaction was not significant ( $F(4,340)=0.73$ ,  $p=0.57$ ), indicating that the effects of emotion were similar for BN and HC participants.

Analysis for response bias data was performed using Mann Whitney U test, because data were not normally distributed. Results showed no differences between BN and HC participants, indicating no evidence of response bias (Anger:  $U(66)=550.50$ ;  $p=0.95$ ; Disgust:  $U(66)=569.00$ ;  $p=0.70$ ; Fear:  $U(66)=531.50$ ;  $p=0.85$ ; Happiness:  $U(66)=546.00$ ;  $p=1.00$ ; Sadness:  $U(66)=530.00$ ;  $p=0.76$ ).

**Figure 3.3. Mean response for emotions at 50%**



BN= Bulimia nervosa; HC= Healthy controls; CI=Confidence Interval.

### **3.3.3.3. Body motion emotion recognition**

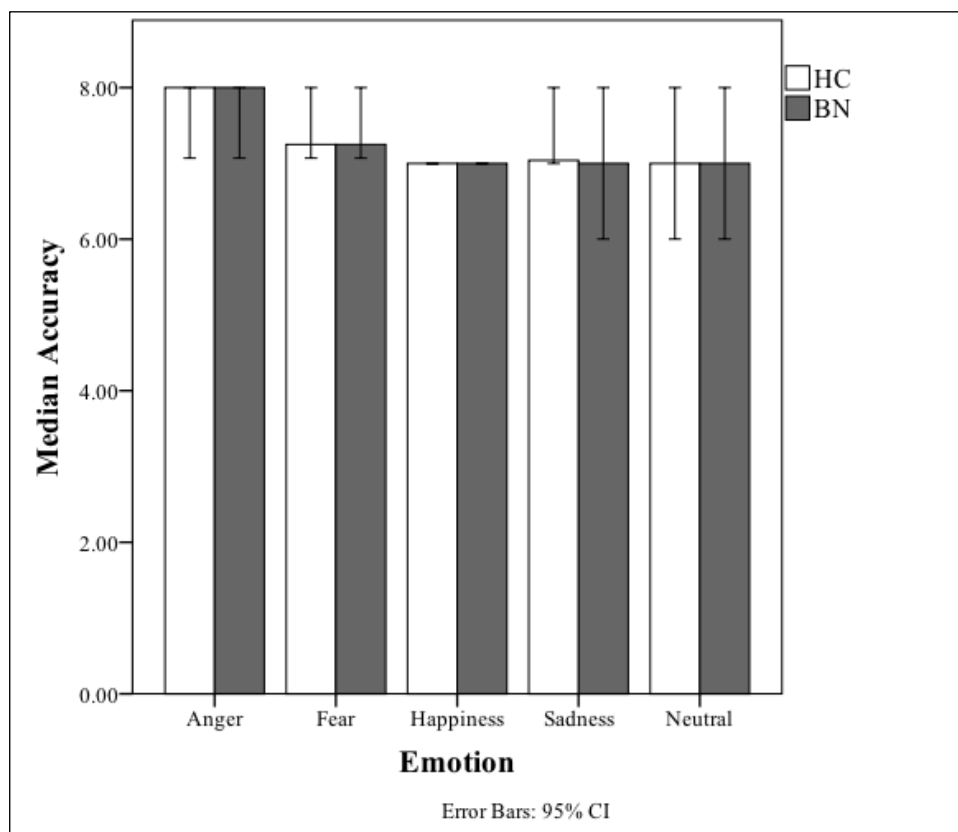
Percentage correct responses for all emotions are shown in table 3.5 and figure 3.4. Results from Mann Whitney U test indicated that participants with BN and HC had similar recognition accuracy for all emotions as well as for the neutral clips (Anger:  $U(66)= 567.50$ ;  $p= 0.75$ ; Fear:  $U(66)= 580.00$ ;  $p= 0.66$ ; Happiness:  $U(66)= 516.50$ ;  $p= 0.70$ ; Sadness:  $U(66)= 513.50$ ;  $p=0.67$ ; Neutral:  $U(66)= 592.50$ ;  $p= 0.54$ ).

**Table 3.5. Percentage correct responses for emotions**

	BN (n=26)				HC (n=42)			
	Mean	SD	Mdn	IQR	Mean	SD	Mdn	IQR
Anger	7.63	0.56	8.00	0.93	7.56	0.66	8.00	1.00
Fear	7.31	0.83	7.25	0.95	7.25	0.78	7.25	1.00
Happiness	6.80	0.74	7.00	1.01	6.94	0.71	7.00	1.11
Sadness	6.76	1.31	7.00	2.14	6.87	1.32	7.04	1.64
Neutral	7.04	1.11	7.00	2.00	6.93	1.00	7.00	2.00

BN= Bulimia nervosa; HC= Healthy controls; SD= Standard deviation; Mdn= Median; IQR= Interquartile range.

**Figure 3.4. Median accuracy for emotions**



BN= Bulimia nervosa; HC= Healthy controls; CI=Confidence Interval.

Percentage response bias for all emotions and the neutral clips is shown in table 3.3.6. Results of Mann Whitney U test showed no evidence of bias recognising emotions in the clips (Anger:  $U(66) = 500.00$ ;  $p = 0.51$ ; Fear:  $U(66) = 584.00$ ;  $p = 0.51$ ; Happiness:  $U(66) = 530.00$ ;  $p = 0.82$ ; Sadness:  $U(66) = 530.50$ ;  $p = 0.84$ ; Neutral:  $U(66) = 579.00$ ;  $p = 0.67$ ).

**Table 3.6. Percentage response bias for emotions**

	BN (n=26)				HC (n=42)			
	Mean	SD	Mdn	IQR	Mean	SD	Mdn	IQR
Anger	2.24	3.38	0.00	4.17	2.78	3.52	0.00	4.17
Fear	1.44	2.87	0.00	4.17	1.09	2.45	0.00	0.00
Happiness	2.24	3.17	0.00	4.17	2.58	3.68	0.00	4.17
Sadness	4.97	5.53	4.17	8.33	4.66	4.03	4.17	8.33
Neutral	8.65	6.45	8.33	8.33	8.43	7.45	8.33	8.33

BN= Bulimia nervosa; HC= Healthy controls; SD= Standard deviation; Mdn= Median; IQR= Interquartile range.

### **3.3.4. DISCUSSION**

This study investigated emotion recognition from faces and body motion in women with BN. The results showed that, when compared to HC, BN participants had difficulties recognising facial disgust when depicted in a less ambiguous fashion (i.e., in facial expressions that showed disgust at a 90% proportion), and tended to misinterpret it as anger. In addition, results of response bias indicated that BN participants tended to interpret non-angry faces as anger. There were no other differences between BN and HC participants.

Results from the facial emotion recognition task are in agreement with previous studies on adults with BN, showing no overall impairment, but slight difficulties recognising a specific emotion in the face. However, the evidence of difficulties recognising disgust is novel, as previous studies reported difficulties in other emotions, specifically in surprise (Kessler et al., 2006; Legenbauer et al., 2008) and anger (Kuhnpast et al., 2012).

Difficulties recognising disgust in facial expressions have been found in people with AN (Lule et al., 2014; Pollatos, Herbert, Schandry, & Gramann, 2008), and results from this study are consistent with findings from study 3.1 with AN participants exhibiting difficulties recognising disgust and misinterpreting it as anger. It has been suggested that there are similarities in the neural regions implicated in some aspects of social cognition, such as theory of mind, in people with BN and AN (McAdams & Krawczyk, 2013). Thus, the study findings may reflect similarities in neural processing in BN and AN. It has been proposed that emotion processing difficulties in people with AN could be explained by a dysfunction of the insula (Nunn, Frampton, Gordon, & Lask, 2008), which is the brain region implicated in the processing of disgust facial expressions (Phillips et al., 1997). Altered function of the insula has been shown in BN participants in response to sweet tastes (Oberndorfer et al., 2013), but not in response to angry and disgusted facial expressions (Ashworth et al., 2011). Therefore, it is unclear whether a dysfunction of the



insula could explain the difficulties in disgust processing exhibited by participants with BN in this study.

In addition to facial recognition accuracy, the study investigated response bias in BN. The results showed a response bias towards anger in less ambiguous facial expressions. This finding is consistent with the results of AN participants in study 3.1. People with AN and BN have shown attentional bias towards angry and rejecting faces (Cardi et al., 2013; Harrison et al., 2010), which could result in more attention to be paid to slight signs of anger, or to muscular actions that anger shares with other emotions, such as brow lowering (usually involved in both, anger and disgust) (Gery, Miljkovitch, Berthoz, & Soussignan, 2009). Thus, there is misinterpretation of the whole facial expression as anger.

Moreover, the confusion between disgust and anger shown by BN participants in this study may be indicative of more general difficulties in anger and disgust processing. It has been theorised that certain emotions that are particularly unacceptable may be inhibited and replaced by others that are more acceptable, and that in the case of people with ED anger and disgust may become coupled during the course of emotional development (Fox & Froom, 2009). According to this, anger is perceived by individuals with ED as threatening, and may be replaced by disgust, usually directed towards oneself (Fox & Froom, 2009). In support to this theory participants with disordered eating behaviours, including BN features such as bingeing and purging, exhibited high sensitivity to disgust after an angry mood induction (Fox & Harrison, 2008). It may be that, as a result of this emotion coupling, people with BN have difficulties distinguishing disgust and anger, which would explain the misinterpretation of disgust faces as anger, and to a less extent, the bias towards anger and disgust (at a trend level) shown by BN participants.

This study also explored emotion recognition in body motion in people with BN. Results indicated that participants with BN did not differ from HC in their ability to recognise

emotions from body movements. The lack of differences could be explained by clips not depicting disgust in the body motion recognition task. If the difficulties recognising emotions in people with BN are limited to disgust recognition, then it would be expected not to find differences in other emotions as those assessed in the body motion recognition task. An alternative explanation may be related to characteristics of the task used in the study, with clips in which emotions were exaggerated to increase their recognisability (Atkinson et al., 2004), which could have obscured difficulties recognising more subtle expressions.

The findings for BN participants in body motion emotion recognition are similar to those with AN in study 3.1, in which adult participants with AN generally exhibited similar performance to HC.

Half of the participants in the BN group assessed in this study had a past history of AN, which is not rare given the evidence of high crossover between diagnosis (Anderluh, Tchanturia, Rabe-Hesketh, Collier, & Treasure, 2009; Eddy et al., 2008). The similarities in emotion recognition exhibited by participants with BN and AN, along with other shared characteristics of socio-emotional processing (Cardi et al., 2013; Harrison et al., 2014; Harrison et al., 2010) may suggest that the ability to recognise emotions might be transdiagnostic in ED.

This study has some limitations. First, the relatively small sample size for the BN group may have affected the results. Particularly, the trend towards significance for a response bias towards disgust found in the face emotion recognition part, could suggest that the study was underpowered. In addition, results from both emotion recognition tasks were negatively skewed and may be indicating a ceiling effect in which the task complexity is not high enough to capture difficulties.

In conclusion, results from this study do not suggest major difficulties in emotion recognition in BN, which is consistent with the findings from a review on social cognition in this group (Dejong et al., 2013). Nevertheless, the study findings indicate subtle

difficulties recognising disgust, and a response bias towards angry when recognising emotions in the face. The similarities in the performance of BN participants in this study and AN participants in study 3.1 and 3.2 may suggest that problems in emotion recognition are transdiagnostic in ED.

## **CHAPTER 4**

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### **EMOTION EXPRESSION IN EATING DISORDERS**

## **OVERVIEW**

This chapter focuses on the ability to express emotions through the face in people with ED. The chapter begins with a published study on spontaneous facial expressions of positive emotions in ED participants, followed by a non-published study on the expression of negative emotions in the same population. Finally, the chapter ends with a published study on non-spontaneous facial expression of emotions, focused on posed facial expressions and imitation in people with ED.

## **CHAPTER 4**

### **STUDY 1**

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FACIAL EXPRESSION OF POSITIVE EMOTIONS IN INDIVIDUALS  
WITH EATING DISORDERS

## **FACIAL EXPRESSION OF POSITIVE EMOTIONS IN INDIVIDUALS WITH EATING DISORDERS**

Facial expressions of positive emotions, such as happiness/joy have an important role on social interaction (LaFrance, 2011), signaling cooperative intentions (Schmidt & Cohn, 2001) and facilitating sociability (Matsumoto, Keltner, Shiota, O'Sullivan, & Frank, 2008). In this study, facial expressions of positive emotions in women with AN, BN and HC are investigated through the Duchenne smile (Ekman, Davidson, & Friesen, 1990), which is the smile that has shown to be associated with genuine positive affect (Ekman, Davidson, & Friesen, 1990).

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## Facial expression of positive emotions in individuals with eating disorders

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### ABSTRACT

A large body of research has associated Eating Disorders with difficulties in socio-emotional functioning and it has been argued that they may serve to maintain the illness. This study aimed to explore facial expressions of positive emotions in individuals with Anorexia Nervosa (AN) and Bulimia Nervosa (BN) compared to healthy controls (HC), through an examination of the Duchenne smile (DS), which has been associated with feelings of enjoyment, amusement and happiness (Ekman et al., 1990). Sixty participants (AN=20; BN=20; HC=20) were videotaped while watching a humorous film clip. The duration and intensity of DS were subsequently analyzed using the facial action coding system (FACS) (Ekman and Friesen, 2003). Participants with AN displayed DS for shorter durations than BN and HC participants, and their DS had lower intensity. In the clinical groups, lower duration and intensity of DS were associated with lower BMI, and use of psychotropic medication. The study is the first to explore DS in people with eating disorders, providing further evidence of difficulties in the socio-emotional domain in people with AN.

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### 1. Introduction

Facial expressions play a key role in human social interaction. They convey people's emotional experience (Ekman, 1990) and are used as social signals that communicate information to others (Fridlund, 1994). They are also essential for establishing rapport (Tickle-Degnen, 2006), deepening people's sense of connection and alliance during social interaction (Schmidt and Cohn, 2001). In contrast, lack of facial expression can be interpreted as an attempt to avoid attention in social settings, becoming undetected (Fridlund, 1994). Studies on individuals with limited facial expression indicate that people perceive them as reserved and unhappy (Tickle-Degnen and Lyons, 2004; Bogart et al., 2014) and report being less interested in establishing friendship ties with them (Hemmesch et al., 2009).

Facial expressions of positive emotions, such as smiling, have

been related to cooperative intentions (Schmidt and Cohn, 2001), readiness to play or connect (Fridlund, 1994), and social rewards (Shore and Heerey, 2011). People associate smiling with happiness, positive intentions (Floyd and Burgoon, 1999), and increased sociability (Matsumoto and Kudoh, 1993).

Early on, Charles Darwin noted that spontaneous smiles were characterized by the activation of the muscle that contracts the outer corner of the eyebrows (i.e., orbicularis oculi) producing wrinkles in the corner of the eyes, in addition to the zygomatic major, which moves the corner of the lips upwards towards the cheekbones (Darwin, 1872). This is known as the Duchenne smile (DS) (Duchenne, 1990; Ekman et al., 1990). DS have been associated with reports of enjoyment, amusement and happiness (Ekman et al., 1990; Ruch, 1995), as well as specific patterns of brain activity (Ekman et al., 1990; Davidson et al., 1990). In contrast, Non-Duchenne smiles (NDS) do not involve the action of the orbicularis oculi, and are not associated with the experience of positive affect. Whereas DS have shown to evoke positive emotions in others, promoting positive social interactions and well being, NDS do not (Keltner and Bonanno, 1997; Harker and Keltner, 2001). Instead, NDS may be displayed in a deliberate attempt to

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convince others that a positive emotion is being felt when it is not (Ekman and Friesen, 1982), or as a way of signaling anticipation of the possibility of experiencing enjoyment (Ekman et al., 1990), and is often produced in response to social demands (Hess and Bourgeois, 2010).

Facial expression is part of a coordinated system of emotional responses (Levenson, 1994). It has been argued that in people who experience psychological difficulties, elements of this system may lack coordination, thus becoming dysfunctional (Rosenberg and Ekman, 1994). Studies in clinical populations have shown differences in the expression of DS in response to positive stimuli, compared to healthy controls (HC). For example, individuals suffering from depression have been found to produce fewer DS when exposed to positive stimuli (Ekman et al., 2005) and to show smiles that were followed by negative affect-related expressions in response to amusing film clips (Reed et al., 2007). Participants with schizophrenia display fewer DS when induced to feel positive emotions through remembering biographic emotional situations (Kohler et al., 2008). Similar results have been found for participants with post-traumatic stress disorder during a psychodynamic interview (Kirsch and Brunnhuber, 2007).

Eating disorders are characterized by disturbances in patients' eating patterns, body image or body weight, which may lead to physical, cognitive or social difficulties (Fairburn and Harrison, 2003; Tchanturia et al., 2013). People with eating disorders exhibit high levels of comorbidity with disorders that have shown to be related to reduced facial expression, such as anxiety and depression (Herzog et al., 2000). In addition, socio-emotional difficulties found in eating disorders include high levels of alexithymia (Nowakowski, et al., 2013), social anhedonia (Tchanturia et al., 2012), self-silencing (i.e., the tendency to avoid expressing negative emotions) (Hambrook et al., 2011), and fear of the social consequences of expressing emotions (Ioannou and Fox, 2009; Hambrook et al., 2011). It has been proposed that socio-emotional difficulties may contribute to the maintenance of the eating disorder psychopathology (Treasure et al., 2012; Schmidt and Treasure, 2006; Speranza et al., 2007) and in the case of AN, that eating disorder symptoms function, in part, to help the individual cope with aversive emotional states (Wildes et al., 2010).

A few studies have investigated facial expressions in people with eating disorders (Davies et al., 2011, 2013; Rhind et al., 2014). Davies et al. (2011) found that adult AN patients showed fewer facial expressions when watching negative and positive films, and reported feeling less positive emotions and similar levels of negative emotions, compared to HC. Similar results were described in young people with AN (Rhind et al., 2014). Claes et al. (2012) used a different experimental procedure to monitor facial expression of anger and joy in AN and BN participants when playing a therapeutic video game and reported that AN patients exhibited less anger through their facial expressions compared to HC. In BN participants, facial expression of anger was not significantly reduced compared to HC. The study found no differences among the groups in their facial expressions of joy. In a second study using the same paradigm, patients with BN showed higher levels of joyous facial expressions, and reduced facial expression of anger compared to HC (Tárrega et al., 2014). Reduced expression of emotions may contribute to the difficulties in the socio emotional area, worsening the impact of the eating disorder in patients' social functioning (Tchanturia et al., 2013).

The studies described above provide preliminary evidence suggesting that patients with AN and BN show reduced negative facial emotional expression (sadness and anger) compared to HC. However, results for facial expressions of positive emotions are more equivocal: AN showed fewer positive facial expressions compared to HC when using film clips as mood elicitors, but not

when using a video game. Furthermore, BN participants seem to display as many positive facial expressions as HC. Studies on positive emotions are scarce in the eating disorders field, and there is a need for further investigation in the area (Tchanturia et al., 2015). Therefore, this study aimed to build upon previous findings, by further investigating positive facial expression of emotions in AN and BN. Specifically, examining the expression of DS as an expression of genuine positive affect and potential benefits for well being, in comparison to NDS.

Based on previous findings, it was hypothesized that participants with AN will show fewer DS and NDS, compared to HC. Even though the literature on BN is more limited, it was hypothesized that this group will produce similar levels of DS and NDS to HC. To our knowledge, this is the first study to investigate DS in people with eating disorders.

## 2. Method

### 2.1. Participants

Sixty adult women, grouped into 20 AN (9 restricting type, and 11 binge-eating/purging type), 20 BN and 20 HC, were included in the study. Given that studies using FACS were not available in the eating disorders literature, studies carried out on other psychiatric populations (mainly schizophrenia and mood disorders) were used to estimate the sample size. It was estimated that a sample size of 20 participants per group would allow detecting medium to large effect sizes with 80% of power, setting  $\alpha < 0.01$ . Participants with eating disorders were recruited from specialist eating disorders services, and through advertisement on the Beat website (<http://www.b-eat.co.uk/>). The HC group was recruited from the local community. Eating disorder diagnosis was assessed using the Eating Disorders module of the Structured Clinical Interview for DSM-IV-TR Axis I Disorders (SCID-I) (First et al., 2002). The inclusion criterion for the clinical groups was a diagnosis of AN or BN, according to DSM-5 (APA, 2013). A body mass index less than 18.5 was used as a threshold for AN diagnosis. Participants were excluded from the study if they have had a head injury, autism spectrum disorders, and psychosis, were not fluent in English, or were unable to provide informed consent. The same exclusion criteria as well as the absence of current or past eating disorder were applied for the HC group. Participants were compensated for their time with £10.

### 2.2. Measures

#### 2.2.1. Body mass index (BMI in kg/m<sup>2</sup>)

This was calculated from measures of height and weight obtained on the day of the assessments.

#### 2.2.2. Structured clinical interview for DSM IV disorders (SCID-I) (First et al., 2002)

The eating disorders module of the SCID-I was used to assess current or past diagnosis in all participants. In order to adjust the interview to DSM-5 criteria, amenorrhea was not required for AN diagnosis, and the frequency of binge eating and purging behavior was reduced to once a week for the diagnosis of BN.

#### 2.2.3. Eating disorder examination questionnaire (EDE-Q) (Fairburn and Beglin, 1994)

This 36 item self-report questionnaire is designed to assess eating disorders symptomatology. It has four subscales (i.e., dietary restraint, eating concern, weight concern, and shape concern) and a global score that ranges from 0 to 6.

#### 2.2.4. Hospital anxiety and depression scale (HADS) (Zigmond and Snaith, 1983)

The HADS is a 14 item self-report questionnaire with two subscales assessing anxiety and depression levels. Each subscale ranges from 0 to 21. The questionnaire has shown to have good validity and reliability (Bjelland et al., 2002).

#### 2.2.5. Toronto alexithymia scale (TAS-20) (Bagby et al., 1994)

A 20 item questionnaire widely used to assess alexithymia, which is defined as a difficulty in identifying and describing emotions. This questionnaire has good psychometric properties (Parker et al., 2003). The questionnaire consists of three subscales (i.e., difficulty identifying feelings, difficulty describing emotions, and externally oriented thinking) and a total score that ranges from 20 to 100.

#### 2.2.6. Positive and negative affect scale (PANAS) (Watson et al., 1998)

The PANAS is a 20 items two-factors self-report scale developed to assess positive and negative affect. In the current study, the positive affect scale was used to assess the extent to which the film clip was able to induce positive affect in the participants. The positive affect PANAS scale has 10 descriptors (i.e., attentive, interested, alert, excited, enthusiastic, inspired, proud, determined, strong, and active) and its score ranges from 10 to 50.

Internal consistencies ( $\alpha$ ) for the measures in the current sample were: EDE-Q: 0.98; HADS Anxiety: 0.72; HADS Depression: 0.69; TAS-20: 0.92; and PANAS positive: 0.89.

### 2.3. Experimental task

First, a neutral film depicting waves was presented for 30 s. Next, participants completed the positive PANAS questions (pre-film), in order to establish a baseline measure of positive affect before the emotion elicitation. Following this, a 2 min clip showing a humorous wedding ceremony was shown. This clip was taken from the film “Four Weddings and a Funeral” and it was chosen because it has shown in previous studies to elicit positive emotions in people with AN and HC (e.g. Davies et al., 2011). Finally, the positive PANAS questions were repeated (post-film). Participants were alone during the task and were aware that they were being recorded. Videos and instructions were shown on a 13-inches laptop computer screen with a built-in camera that recorded the participant's facial expressions during the task.

### 2.4. Procedure

Participants attended one session during which all procedures were carried out. As part of the informed consent participants were informed that the purpose of the study was “to explore the way people with and without eating disorders deal with emotions”, and were asked for their permission to be videotaped during the experimental procedures. After they gave their informed consent, the SCID was conducted, and weight and height were measured. Then, participants completed the experimental task and questionnaires. The videos showing participants' facial expressions while watching the humorous film were then coded using the facial action coding system (FACS). The study was approved by the National Health Research Ethics Services Committee (13/LO/0201).

### 2.5. Coding of facial expression

The facial action coding system (FACS) was developed by Ekman and Friesen for measuring observable facial expressions (Ekman and Friesen, 2003). It provides a method to objectively code any anatomically possible action produced in the face using 44

action units (AUs), in which each AU describes the movement of specific muscles in the face. The coding system can be used to identify action units (AUs), their intensity, as well as combinations of AUs. In FACS, the DS is identified as a combination of AU12 (lip corners pulling, by the action of the zygomaticus major) and AU6 (cheek raising, by the action of the orbicularis oculi), and differentiated from NDS, which does not involve AU6. For a detailed description of FACS, see Ekman and Rosenberg (2005).

Videos were coded by two coders (SH; CH), who were blind to the participants' clinical status (AN, BN, or HC) and to the study hypotheses, under the supervision of MD. All coders were certified in FACS. All 44 AUs were coded, and then AU6 and AU12 were selected for analysis. Duration and intensity were used as outcome measures. A measure of proportional viewing duration was calculated by dividing the time (in seconds) a participant had spent displaying the AU combination by the task duration in minutes. For example, if a participant displayed an AU combination for a total of 4 seconds during the 2-minute film clip then the measure would be 4 seconds divided by 2 minutes. The intensity of the AU combination was coded on a 5-point ordinal scale, from trace to maximum intensity.

The AU combinations for DS and NDS were coded exclusively, and did not overlap. In order to assess inter-coder reliability for AU6 and AU12, seven videos (12%) were coded by both coders (SH; CH). The overall agreement percentage was 92%. Mean Cohen's Kappa was 0.80, which indicates excellent agreement (Sayette et al., 2001).

### 2.6. Data analysis

SPSS version 22 was used to analyse the data. Prior to conducting all analyses, distributions were examined to evaluate normality. Non-parametric analyses of variance were conducted for data that was not normally distributed (Kruskal-Wallis and Mann-Whitney U post-hoc tests). Effect sizes were calculated by using Cohen's *d* (Cohen, 1998) for parametric tests, and Rosenthal's *r* (Rosenthal and Rubin, 2003) for non-parametric tests. In order to test the mood induction, repeated measures ANOVA was used comparing pre-film and post-film PANAS (within-group) among the three groups (AN, BN, or HC; between-subject factor). ANOVA and post-hoc t-tests were performed to compare the three groups on smile duration and intensity, when data was normally distributed. In order to explore associations of DS and NDS in the clinical group, AN and BN participants were grouped together ( $n=40$ ) and Spearman correlations were calculated between the smiles and BMI, length of illness, EDE-Q, HADS-A, HADS-D, and TAS-20 measures. To explore the effect of medications in DS and NDS the clinical group was split into clinical participants who were taking medications ( $n=17$ ) and those who were not ( $n=23$ ). Mann Whitney U test and Rosenthal's *r* effect size were calculated to compare the duration and intensity of DS and NDS in both groups. Bonferroni correction for multiple testing was applied.

## 3. Results

Participant's demographic and clinical characteristics are described in Table 1. As expected, clinical participants differed from HC on measures of eating disorders, anxiety, depression, and alexithymia. In addition, AN participants had lower BMI than BN and HC groups. Eating disorder participants did not differ on EDE-Q subscales, although there was a trend towards significant difference in dietary restraint (EDE-Q diet. rest.:  $M_{AN}=4.29$ ,  $M_{BN}=3.31$ ,  $t(38)=1.98$ ,  $p=0.06$ ). There was no difference in the length of illness of AN and BN participants.

Sixty percent of the participants with AN were taking

**Table 1**  
Demographic and clinical characteristics.

	AN (n=20)	BN (n=20)	HC (n=20)	Group statistics	Post-hoc tests		
	M (SD)	M (SD)	M (SD)		AN vs. BN	AN vs. HC	BN vs. HC
Age	28.85 (9.75)	26.85 (6.75)	26.40 (7.60)	$F(2,57)=0.52$ $p=0.60$	N/A	N/A	N/A
BMI	15.59 (1.83)	22.15 (3.02)	22.47 (2.68)	$F(2,57)=45.97$ $p < 0.01$	$t(38)=8.29$ $p < 0.01$ $d=2.63$	$t(38)=9.49$ $p < 0.01$ $d=3.00$	$t(38)=0.36$ $p=0.72$ $d=0.11$
Length of illness	11.55 (11.26)	7.95 (6.46)	N/A	$t(38)=1.24$ $p=0.23$	N/A	N/A	N/A
EDE-Q	4.38 (1.04)	3.98 (1.37)	0.48 (0.42)	$F(2,57)=88.29$ $p < 0.01$	$t(38)=1.02$ $p=0.31$ $d=0.32$	$t(25)=15.51$ $p < 0.01$ $d=4.92$	$t(23)=10.97$ $p < 0.01$ $d=2.82$
HADS-A	13.15 (3.60)	12.05 (2.82)	5.95 (1.85)	$F(2,57)=37.08$ $p < 0.01$	$t(38)=1.08$ $p=0.29$ $d=0.34$	$t(28)=7.95$ $p < 0.01$ $d=2.52$	$t(38)=8.09$ $p < 0.01$ $d=2.56$
HADS-D	10.60 (3.15)	9.70 (3.39)	3.85 (1.60)	$F(2,57)=33.61$ $p < 0.01$	$t(38)=0.87$ $p=0.39$ $d=0.28$	$t(28)=8.54$ $p < 0.01$ $d=2.70$	$t(27)=6.98$ $p < 0.01$ $d=2.21$
TAS-20	60.45 (4.79)	56.35 (14.25)	34.75 (2.52)	$F(2,57)=12.36$ $p < 0.01$	$t(38)=0.95$ $p=0.35$ $d=0.39$	$t(26)=8.02$ $p < 0.01$ $d=6.72$	$t(25)=6.27$ $p < 0.01$ $d=2.11$

AN=anorexia nervosa; BN=bulimia nervosa; HC=healthy control; n=number of participants; M=mean; SD=standard deviation; F=Anova test; N/A=non-applicable; BMI=body mass index; t=t-test; d=Cohen's d effect size test; EDE-Q=Eating disorders examination questionnaire; HADS-A=Hospital anxiety and depression scale, anxiety subscale; HADS-D=Hospital anxiety and depression scale, depression subscale; TAS-20=Toronto alexithymia scale. Bonferonni correction applied, statistical significance at  $p < 0.016$

psychotropic medication at the time of the study ( $n=12$ ). The majority was using a combination of selective serotonin reuptake inhibitors (SSRI) and Olanzapine ( $n=4$ ), or SSRI exclusively ( $n=3$ ); other AN participants were taking benzodiazepines ( $n=2$ ) or other psychotropic medication ( $n=3$ ). On the other hand, 25% of the participants with BN were using psychotropic medication ( $n=5$ ), all taking SSRI. None of the HC participants was taking psychotropic medications.

### 3.1. Mood induction

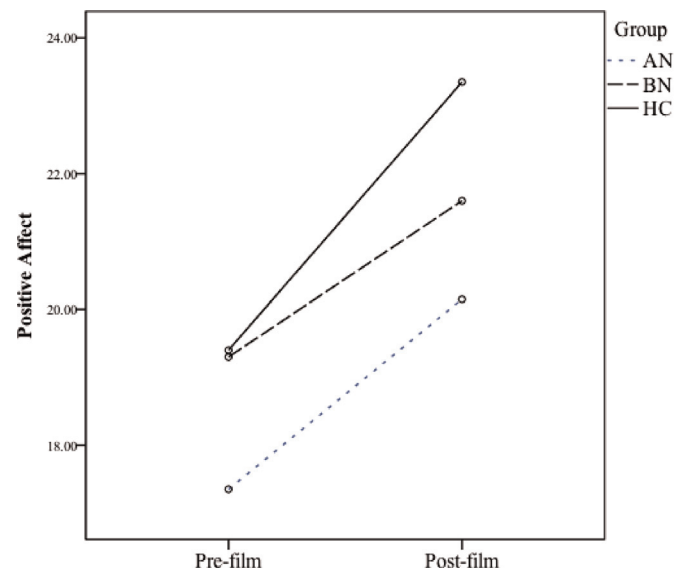
Pre-film and post-film PANAS were compared to test the extent to which the film had been able to produce a change in participants' affect. Results indicated that there was a significant effect of film, with a significant increase in positive affect after viewing the film ( $F(1,57)=18.7$ ,  $p < 0.01$ ). There was no significant effect of group ( $F(2,57)=0.8$ ,  $p=0.44$ ) and the group X film interaction was not significant ( $F(2,57)=0.5$ ,  $p=0.62$ ), suggesting similar increase in positive affect in all groups after viewing the film clip (Fig. 1).

### 3.2. Duchenne smiles (DS)

Analyses of variance revealed that the groups differed significantly in duration and intensity of DS (Table 2). Post-hoc tests indicated that the AN group had significantly less DS duration and intensity compared to the BN group and to the HC group. BN participants did not differ from HC on intensity and duration. Effect sizes were between medium and large.

### 3.3. Non-Duchenne smiles (NDS)

The analyses of variance indicated that the groups differed in duration and intensity of NDS. Post-hoc analyses showed less duration of NDS for both eating disorder groups compared to HC. AN and BN groups were not found to significantly differ in their duration of NDS. AN participants were shown to have significantly less intense NDS compared to the BN and HC groups, but the BN group did not differ from the HC group on NDS intensity. Effect sizes were small to large.



**Fig. 1.** Pre-film and post-film positive affect PANAS scores., AN=Anorexia nervosa; BN=bulimia nervosa; HC=healthy controls.

### 3.4. Association with clinical characteristics within the clinical sample

In order to explore the association of DS and NDS with clinical characteristics, AN and BN participants were grouped together ( $n=40$ ) and their association with BMI, length of illness, eating disorder symptoms, anxiety, depression, and alexithymia was investigated. It was decided to investigate the clinical group as a whole because of the evidence of high diagnostic crossover between AN and BN (Eddy et al., 2008), and to ensure sufficient power for the analysis. Results indicated that in the clinical group, DS duration and intensity were significantly associated with BMI. None of the other clinical characteristics (length of illness, eating disorder symptoms, anxiety, depression, and alexithymia) were found to be significantly associated with DS. When exploring

**Table 2**

Duchenne and Non-Duchenne smiles in clinical and HC groups.

	AN (n=20)	BN (n=20)	HC (n=20)	Group statistics	Post-hoc tests		
	<i>Mdn</i> ( <i>IQR</i> )	<i>Mdn</i> ( <i>IQR</i> )	<i>Mdn</i> ( <i>IQR</i> )		AN vs. BN	AN vs. HC	BN vs. HC
Duchenne smiles duration (s/min)	0.00 (0.42)	0.83 (1.59)	2.08 (2.28)	$\chi^2(2)=15.86$ <b><math>p &lt; 0.01</math></b>	$U=114.00$ <b><math>p &lt; 0.01</math></b> $r=0.39$	$U=71.50$ <b><math>p &lt; 0.01</math></b> $r=0.57$	$U=115.00$ $p=0.02$ $r=0.37$
Duchenne smiles intensity	0.00 (1.75)	3.00 (2.50)	3.00 (1.50)	$\chi^2(2)=18.25$ <b><math>p &lt; 0.01</math></b>	$U=88.00$ <b><math>p &lt; 0.01</math></b> $r=0.51$	$U=62.00$ <b><math>p &lt; 0.01</math></b> $r=0.63$	$U=159.50$ $p=0.23$ $r=0.19$
Non-Duchenne smiles duration (s/min)	0.83 (1.66)	1.66 (2.50)	3.74 (2.49)	$\chi^2(2)=16.26$ <b><math>p &lt; 0.01</math></b>	$U=135.50$ $p=0.08$ $r=0.28$	$U=62.00$ <b><math>p &lt; 0.01</math></b> $r=0.60$	$U=100.50$ <b><math>p &lt; 0.01</math></b> $d=0.43$
Non-Duchenne smiles intensity	2.00 (1.00)	3.00 (1.00)	3.00 (1.00)	$\chi^2(2)=20.26$ <b><math>p &lt; 0.01</math></b>	$U=107.50$ <b><math>p &lt; 0.01</math></b> $r=0.41$	$U=49.00$ <b><math>p &lt; 0.01</math></b> $r=0.67$	$U=115.50$ $p=0.02$ $r=0.34$

AN=anorexia nervosa; BN=bulimia nervosa; HC=healthy control; n=number of participants; *Mdn*=median; *IQR*=interquartile range; s/min=seconds per minute;  $U$ =Mann Whitney  $U$  test;  $\chi^2$ =Kruskal-Wallis test;

$r$ =Rosenthal's

$r$  effect size test;  $t$ = $t$ -test;  $d$ =Cohen's  $d$  effect size test. Bonferroni correction applied, statistical significance at  **$p < 0.016$**

**Table 3**

Correlations between DS, NDS and clinical characteristics within the clinical sample.

	BMI	Length of Illness	EDE-Q	HADS-A	HADS-D	TAS-20
Duchenne smiles (duration)	$r_s=0.426$ <b><math>p=0.006</math></b>	$r_s=0.097$ $p=0.551$	$r_s=-0.053$ $p=0.746$	$r_s=-0.372$ $p=0.018$	$r_s=-0.109$ $p=0.505$	$r_s=-0.310$ $p=0.052$
Duchenne smiles intensity	$r_s=0.486$ <b><math>p=0.001</math></b>	$r_s=0.090$ $p=0.580$	$r_s=-0.098$ $p=0.549$	$r_s=-0.393$ $p=0.012$	$r_s=-0.141$ $p=0.387$	$r_s=-0.279$ $p=0.081$
Non-Duchenne smiles (duration)	$r_s=0.296$ $p=0.063$	$r_s=0.081$ $p=0.621$	$r_s=0.016$ $p=0.920$	$r_s=-0.396$ $p=0.011$	$r_s=-0.033$ $p=0.842$	$r_s=-0.448$ <b><math>p=0.004</math></b>
Non-Duchenne smiles intensity	$r_s=0.463$ <b><math>p=0.003</math></b>	$r_s=-0.010$ $p=0.952$	$r_s=-0.119$ $p=0.464$	$r_s=-0.239$ $p=0.137$	$r_s=-0.052$ $p=0.750$	$r_s=-0.273$ $p=0.089$

BMI=Body mass index; EDE-Q=Eating disorder examination questionnaire; HADS-A=Hospital anxiety and depression scale, anxiety subscale; HADS-D=Hospital anxiety and depression scale, depression subscale; TAS-20=Toronto alexithymia scale;  $r_s$ =Spearman's rank correlation coefficient. Bonferroni correction applied, statistical significance at  **$p < 0.008$**

associations within the AN group ( $n=20$ ), similar results were obtained with significant associations between DS intensity and BMI ( $r_s=0.49$ ,  $p=0.03$ ), and a trend towards significance in the case of DS duration and BMI ( $r_s=0.44$ ,  $p=0.05$ ).

In the eating disorders group, the duration of NDS was found to be negatively associated with TAS-20, and NDS intensity was significantly associated with BMI. NDS was not found to be associated with the other clinical measures (see Table 3). On the other hand, in the AN participants, NDS was associated with anxiety ( $r_s=-0.50$ ,  $p=0.02$ ).

In regards to medication use, clinical participants who were taking psychotropic medications at the time of the study had less DS duration ( $U(38)=117.00$ ,  $p=0.03$ ,  $r=-0.36$ ), and their DS were less intense ( $U(38)=112.00$ ,  $p=0.02$ ,  $r=-0.39$ ). There were no differences on duration or intensity of NDS between medicated and non medicated clinical participants (duration:  $U(38)=135.50$ ,  $p=0.10$ ; intensity:  $U(38)=163.00$ ,  $p=0.39$ ).

#### 4. Discussion

Smiles are potent social signals that are vital for human communication (La France, 2011), and thus their examination in people with eating disorders can offer significant insight into their socio-emotional functioning and contribute to treatment innovations. The present study aimed to investigate positive facial expression in people with eating disorders through an examination of Duchenne smile (DS) expressed in response to a positive, humorous film clip.

It was hypothesized that participants with AN will exhibit reduced DS and NDS when compared to HC, and that BN participants will produce DS and NDS at similar levels to HC.

Results indicated that the film clip successfully increased positive emotions in all participants, but they differed in their facial expression. Specifically, participants with AN displayed DS for shorter durations than BN and HC participants, and their DS had lower intensity. These results extend previous findings of reduced positive facial expression in AN, by obtaining similar results using a different, more detail-oriented facial expression coding system (Davies et al., 2011; Rhind et al., 2014).

Duchenne smiles (DS) express genuine or authentic enjoyment. Because emotion expression plays a central role in establishing relationships (Keltner and Kring, 1998), the reduced expression of DS in the AN group might reflect broad social-signaling difficulties. Indeed, inhibited emotional expression has been shown to make it more likely for others to perceive the inhibited person as untrustworthy or inauthentic (e.g., English and John, 2013) and to reduce social connectedness (e.g., Mauss et al., 2011). It has also been hypothesized that people who show reduced positive facial expression are trying to avoid people's attention (Fridlund, 1994). AN is a disorder highly comorbid with social phobia (Swinbourne et al., 2012) and there is evidence that people with AN maintain less eye contact than HC (Cipolli et al., 1989) and experience high levels of social anhedonia (Tchanturia et al., 2012; Harrison et al., 2014). In this context, it is likely that the reduced expression of positive affect would contribute to maintain this pattern of social avoidance in AN.



DS has also been associated with social reward (Shore and Heerey, 2011), therefore, the reduced expression of DS in the AN group may reflect diminished temperamental reward sensitivity that characterizes disorders of overcontrol such as AN, autism spectrum disorders, and obsessive compulsive personality disorder (Lynch et al., 2013; Lynch et al., in press). Heightened temperamental threat sensitivity and diminished reward sensitivity are hypothesized to bias a person to notice the potential for harm over the potential for reward when interacting with others or encountering ambiguous stimuli making it less likely for them to respond with genuine enjoyment or pleasure (Lynch et al., in press; Clark, 2005). Smiling faces have been shown to activate reward-anticipation areas in the brain (Aharon et al., 2001) and AN has been shown to exhibit lower dopamine mediated anticipatory reward relative to BN (Kaye et al., 2013 for review).

Results of this study showed differences in the duration and intensity of DS between AN and BN participants. This may be explained at least in part, by the fact that BN is a disorder characterized by impulsivity (Harrison et al., 2010) while AN is characterized by overcontrol (Lynch et al., 2013). Our results are similar to findings from Claes et al. (2012) who did not find reduced facial expression of joy in BN participants.

Furthermore, participants within the clinical sample with lower BMI, were found to present DS at a lower duration and intensity, compared to those with higher BMI. Given that other eating disorder psychopathology measures, such as length of illness and EDE-Q, were not associated with DS, this finding suggests that starvation may explain, at least in part, the differences in the results found for people with AN and BN. Future studies including participants who are weight restored, but have AN related psychopathology may be able to enlighten the role of starvation in the expression of positive emotions in AN.

An alternative explanation for the differences between the clinical groups in the production of DS and NDS may relate to different levels of social anxiety in AN and BN. It is known that AN is highly comorbid with social phobia (Swinbourne et al., 2012), and there is preliminary evidence that shyness may influence social skills in AN (Winecoff et al., 2015). Since participants were aware they were being filmed during this study, those with AN may have experienced social anxiety and therefore may have been more cautious of their emotional expression. The negative associations between anxiety and both DS and NDS production may provide support for this explanation, even though they were not significant after correcting for multiple testing. Thus, the influence of social anxiety in positive emotion expression when evaluated using videotaped tasks, such as the one used in the current study, may need further investigation.

In order to explore the effects of psychotropic medications in positive emotion expression (i.e. DS) the clinical group was split according to medication use. Participants taking medications (mostly on SSRI, either exclusively or in combination with olanzapine) showed significantly less DS duration and intensity. These findings may seem to contradict evidence of enhanced expression of positive emotions after SSRI treatment found in people with depression (Girard et al., 2014). However, it is worth noting that the majority of participants taking medications in this study were underweight (i.e. AN), and it is known that antidepressants are less effective in this population (Claudio et al., 2009). One explanation for our findings may be that participants taking antidepressants were the ones with more severe depressive symptoms, and depression has been linked to reduced expression of positive affect (Ekman et al., 2005; Girard et al., 2014). However, in our study depressive symptoms did not correlate to duration or intensity of DS. Therefore, the relation between medication and expression of positive emotions remains unclear. To our knowledge, this is the first study to explore the effects of medication in

emotion expression. The results highlight the need to further investigate the impact of psychotropic medication on emotion expression.

In contrast to the results for DS, differences between AN and BN participants on NDS were not statistically significant. Nevertheless, this result should be taken with caution, because the difference approached significance and the effect size was small, but not negligible. Thus, it is unclear whether the lack of difference between AN and BN participants reflects true similarities in NDS expression, or is a result of lack of power. Future studies with a larger sample size might clarify the differences between AN and BN participants in NDS expression.

In this study, both AN and BN groups presented significantly less NDS duration than the HC group. NDS intensity was found to be significantly less for AN participants compared to BN and HC groups. NDS is usually shown in response to social demands (Hess and Bourgeois, 2010), and according to Papa and Bonanno (2008) NDS displayed in positive situations may be appropriate as a signal of social politeness, increasing social integration. Thus, results may indicate that people with eating disorders are less able to comply with social conventions related to the expression of positive emotions in positive contexts. Alternatively, people with eating disorders may be less expressive in general, for both emotional and non-emotional expressions.

In our study, clinical participants with higher levels of alexithymia showed lower NDS duration. Since NDS tend to be expressed as social conventions, rather than expressions of real enjoyment, this finding may suggest that in people with eating disorders, the difficulties identifying and verbalising internal emotional experiences relate to a lack of awareness of social conventions ruling the display of positive affect. It may be beneficial for future studies to explore this idea further.

The study findings have relevant clinical implications. People with AN have reported experiencing difficulties making friends before the eating disorder onset (Doris et al., 2014), and people with eating disorders report that their illness affects social relationships more than any other aspect of life (Tchanturia et al., 2013). Building new social relationships during recovery may be harder for individuals with eating disorders because people are less motivated in building friendships with individuals who do not express emotions (Hemmesch et al., 2009). Moreover, reduced positive facial expression can have an impact on rapport (Tickle-Degnen, 2006), interfering with the therapeutic relationship during treatment.

This study provides further evidence for the need to include interventions aimed at improving socio-emotional processing of positive emotions in eating disorders treatment (Tchanturia et al., 2015), particularly in those with AN and using psychotropic medication. Research of this nature could inform already existing therapies addressing emotion functioning in eating disorders, such as cognitive remediation and emotional skills training (CREST) (Tchanturia and Doris, 2014), emotion acceptance behavior therapy (EABT) for Anorexia Nervosa (Wildes and Marcus, 2011), and radically open-dialectical behavior therapy (RO-DBT) (Lynch et al., in press).

There are limitations to the present study. For example, even though the researchers coding the videos were blind to the group allocation of the participants, some AN participants were visibly underweight and therefore their group allocation may have been revealed. In addition, all participants were female. Given the evidence that women tend to smile more than men (Hess and Bourgeois, 2010), it would be relevant to explore this area in men with eating disorders. Finally, the association analysis within the AN participants carried out in this study needs to be seen as exploratory, given the small sample size for the AN group. In future studies it would be desirable to include a higher number of

participants to examine differences in AN and BN in facial expression of positive emotions.

Future research could replicate this study including a group of weight restored AN participants, to better understand the role of starvation in the results. In addition, studies should explore differences in the expression of negative emotions to better understand if the reduced expression exhibited by AN participants is specific to positive emotions, or generalized to all emotions. Finally, future studies may aim to replicate these findings in social interaction paradigms.

To our knowledge, the study is the first to investigate DS as an expression of genuine positive affect in people with AN and BN. The findings provide empirical support of difficulties in facial expression of positive emotions in people with AN and underline the need to further explore the role of BMI and psychotropic medications in the expression of positive emotions in people with eating disorders.

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## **CHAPTER 4**

### **STUDY 2**

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FACIAL EXPRESSION OF NEGATIVE EMOTIONS IN INDIVIDUALS  
WITH EATING DISORDERS



## **FACIAL EXPRESSIONS OF NEGATIVE EMOTION IN INDIVIDUALS WITH EATING DISORDERS**

### **4.2.1. INTRODUCTION**

It is widely known that the expression of positive emotions can contribute to social relationships, increasing cooperation and affiliation (Schmidt & Cohn, 2001). In contrast, the expression of negative emotions is usually thought to distance us from others (Fischer & Manstead, 2008), and to be associated with negative social consequences (Zeman & Shipman, 1996).

However, a more recent perspective suggests that the expression of negative emotions can have positive effects on the establishment and maintenance of social relationships (Graham, Huang, Clark, & Helgeson, 2008). For example, it has been proposed that the expression of sadness discloses a call for help and support to the receiver, serving an affiliation function (Fischer & Manstead, 2008). Moreover, Graham et al. (2008) declare that since negative emotions tend to convey a person's need, their expression promotes responsiveness, and the development of a sense of intimacy and harmony in relationships. Findings from studies on couple therapy support this idea, showing that the expression of negative emotions leads to more affiliation and wellbeing (Greenberg, Ford, Alden, & Johnson, 1993).

Facial expressions are a powerful means for conveying emotions (Horstmann, 2003), and the ability to facially express emotional states is relevant for social and emotional functioning (Schmidt & Cohn, 2001). Reduced facial expression has been linked to negative responses from partners (Krause, Steimer-Krause, & Hufnagel, 1992), health practitioners (Tickle-Degnen & Lyons, 2004) and people in general (Bogart, Tickle-Degnen, & Ambady, 2014). Thus, a facial expression of negative emotions could have a positive impact on social functioning.

ED patients have difficulties in social functioning (Tchanturia et al., 2013; Treasure, Crane, McKnight, Buchanan, & Wolfe, 2011) that could be explained, at least in part, by difficulties in the emotional domain (Caglar-Nazali et al., 2014; Oldershaw et al., 2011). It has been proposed that people with ED, particularly those with AN, have a tendency to avoid experiencing and expressing intense emotional states (Wildes, Ringham, & Marcus, 2010), and are inclined to suppress negative feelings for fear of conflict with others (Geller, Cockell, Hewitt, Goldner, & Flett, 2000; Hambrook et al., 2011). Maintenance models of ED state that ED symptoms can serve a regulatory function by distracting the patient from intense negative emotions (Treasure & Schmidt, 2013). In fact, inhibited expression of negative emotions has been found to be associated with body dissatisfaction (Geller et al., 2000), and patients with AN have reported increased urges to engage on ED behaviours after a negative mood induction (Wildes, Marcus, Bright, & Dapelo, 2012).

A large number of studies have shown that people with ED have difficulties regulating intense negative emotions (for a review, see Lavender et al., 2015). However, only a few studies have investigated experimentally the facial expression of negative emotions in people with ED. As described in study 4.1, a study conducted by Davies, Schmidt, Stahl, and Tchanturia (2011) used a film clip to elicit negative emotions in people with AN and HC. They found a reduced facial expression of negative emotions in participants with AN, compared to HC, despite reporting similar levels of negative emotions in response to the film clip. Similar results were found in adolescents with AN (Rhind, Mandy, Treasure, & Tchanturia, 2014). In a recent study, Cardi et al. (2015) investigated facial emotion expression of participant with ED in response to video clips showing adults displaying discrete emotions, finding that ED participants showed fewer negative expressions in response to clips displaying anger and sadness. These studies coded facial expressions using the Facial Expression Coding System (FACES, Kring & Sloan, 1991), a coding system that focuses on global dimensions of positive and negative affect displays (Davies et al., 2011), rather than specific expressions of discrete emotions. Using

a different paradigm, Claes et al. (2012) found a reduced facial expression of anger in ED participants, compared to HC, whilst playing a therapeutic video game. A subsequent study with BN participants replicated these results (Tarrega et al., 2014). Of note, these studies used an automatic system to code facial features typical of anger, and focused solely on this negative emotion.

The studies described above provide preliminary evidence of reduced facial expression of negative emotions in people with ED. The current study aimed to build upon these findings, investigating facial expression of sadness and other negative emotions in response to a film clip in people with AN, BN and HC. Unlike previous studies, the current study focused on facial expressions that are specific to discrete negative emotions, and looked at a wider range of emotions (i.e., sadness, anger, disgust, and fear) using Facial Action Coding System (FACS, Ekman, Friesen, & Hager, 2002), which is considered the gold standard for measuring facial behaviour (Sayette, Cohn, Wertz, Perrott, & Parrott, 2001). It was hypothesised that participants with ED will exhibit reduced facial expression of negative emotions, compared to HC.

#### **4.2.2. METHODS**

##### **4.2.2.1. Participants**

Twenty women with AN (9 restricting type, and 11 binge-eating/purging type), 20 with BN, and 20 HC participated in this study. Participants were the same sample of study 3.1, with the exception of one BN participant. Clinical participants met DSM-5 criteria for either AN or BN (APA, 2013), assessed using the Structured Clinical Interview for DSM-IV-TR Axis I Disorders (SCID-I) (First, Gibbon, Spitzer, & Williams, 2002). A body mass index less than 18.5 was used as a clinical threshold for AN. Participants were excluded from the study if they have had a head injury, autism spectrum disorders, or psychosis, were not fluent in English, or were unable to provide informed consent. The

same exclusion criteria as well as the absence of current or past eating disorder were applied for the HC group.

The majority of AN participants was receiving inpatient treatment at the time of the study (n=7; 35%), followed by those receiving either intensive outpatient treatment (i.e. Step-up program) (n=5; 25%) or outpatient treatment (n=5; 25%). Other AN participants were participating in self-help groups (n=1; 5%) or were not receiving treatment (n=2; 10%). BN participants were receiving outpatient treatment (n=7; 35%), intensive outpatient treatment (n=1; 5%), or participated in self-help programmes (n=2; 10%). Half of the BN participants were not receiving treatment at the time of the study (n=10; 50%).

#### **4.2.2.2. Measures**

*4.2.2.2.1. Body Mass Index (BMI; kg / m<sup>2</sup>):* This was determined by measuring height and weight of participants on the day of the assessment.

*4.2.2.2.2. Structured Clinical Interview for DSM-IV-TR Axis I Disorders; SCID-I (First et al., 2002):* The eating disorders module of the SCID-I was used to assess current diagnosis and history of ED in all participants. To adjust the interview to DSM-5 criteria, amenorrhea was not required for AN diagnosis and the frequency of binge eating and purging behaviour was reduced to once a week for the diagnosis of BN.

*4.2.2.2.3. Eating Disorder Examination Questionnaire; EDE-Q (Fairburn & Beglin, 1994):* The EDE-Q is a 36-item self-report measure widely used to evaluate eating disorder cognitions and behaviours. The internal consistency for the EDE-Q global score in the current sample was  $\alpha = 0.98$ .

4.2.2.2.4. *Hospital Anxiety and Depression Scale; HADS (Zigmond & Snaith, 1983)*: The HADS is a 14-item self-report questionnaire with two subscales that evaluate anxiety and depression. Internal consistencies in the current study were  $\alpha=0.72$  for the anxiety subscale, and  $\alpha=0.70$  for the depression subscale.

4.2.2.2.5. *Toronto Alexithymia Scale- 20; TAS-20 (Bagby, Parker, & Taylor, 1994)*: The TAS-20 is a 20-item, self-report questionnaire used to evaluate alexithymia. Internal consistency in this study was  $\alpha=0.92$ .

4.2.2.2.6. *Positive and Negative Affect Scale (PANAS) (Watson, Clark, & Tellegen, 1988)*: The PANAS is a 20 items two-factors self-report scale developed to assess positive and negative affect. In the current study, the negative affect scale was used to assess the extent to which the film clip was able to induce negative affect in the participants. Internal consistencies in this study were  $\alpha=0.78$  for pre-film negative affect and  $\alpha=0.81$  for post-film negative affect.

#### 4.2.2.2.7. *Experimental task*:

First, a neutral film depicting waves was presented for 30 seconds. Next, participants completed the negative PANAS questions (pre-film), in order to establish a baseline measure of negative affect before the emotion elicitation. Following this, a 2 minutes film clip depicting a dying woman saying farewell to her son and husband was shown. This clip was taken from the film “Shadowlands” and it was chosen because it has shown in previous studies to elicit negative emotions, specially sadness, in people with AN and HC (Davies et al., 2011). Finally, the negative PANAS questions were repeated (post-film). Participants were alone during the task and were aware that they were being recorded. Videos and instructions were shown on a 13-inches laptop computer screen with a built-in camera that recorded the participant’s facial expressions during the task.

#### **4.2.2.3. Procedures**

Participants attended one session in which they signed informed consent and all study procedures were carried out. First, the SCID was conducted and weight and height were measured. Then, participants completed the experimental task and questionnaires. The videos showing participants' facial expressions while watching the film were then coded using the Facial Action Coding System (FACS). Participants were compensated for their time with £10. The study was approved by the National Health Research Ethics Services Committee (13/LO/0201).

#### **4.2.2.4. Coding of Facial Expressions**

The FACS (Ekman et al., 2002) was described in detail in chapter 2. The coding method objectively codes any anatomically possible action produced in the face using 44 action units (AUs), in which each AU describes the movement of specific muscles in the face. The coding system can be used to identify action units (AUs), as well as combinations of AUs. Some AUs and AU combinations have been associated with specific emotions, for example AU9 or 'Nose Wrinkler' (i.e., the action that pulls the skin along the sides of the nose upwards towards the root of the nose causing wrinkles) has been associated to disgust (Ekman et al., 2002). For each AU or AU combination, the duration (in seconds per minute) and intensity (from 0 to 5) are computed.

Videos were coded by two FACS-certified coders, who were blind to the participants' clinical status (AN, BN, or HC) and to the study hypotheses. All 44 AUs were coded, and then AUs and AU combinations that are typically present when expressing anger, disgust, fear and sadness were identified. After inspecting all videos, 12 AUs or AU combinations were found, which are listed in table 4.1. For analysis, all AUs and AU combinations that are typically present when expressing a specific emotion were collapsed, adding their duration and averaging their intensity. Thus, the outcome measures were duration and

intensity for each emotion (i.e. sadness duration and intensity, anger duration and intensity, disgust duration and intensity). In addition, a negative emotion score was created adding the duration of all emotions and averaging their intensity.

In order to assess inter-coder reliability, 10% of the videos were coded by both coders and Cohen's kappa was calculated. Given the small number of AU exhibited, it was possible to calculate inter-coder reliability only for AU4, AU10, AU22, and AU23.

Average kappa was 0.73 indicating adequate reliability (Sayette et al., 2001).

**Table 4.1. AU and AU combinations identified in participants' facial expression**

Emotion	Action Unit	Action Unit Name
Sadness	AU1	Inner Brow Raiser
	AU1+4	Inner Brow Raiser and Brow Lowerer
Anger	AU4	Brow Lowerer
	AU23	Lip Tightener
	AU24	Lip Presser
	AU10+22	Upper Lip Raiser and Lip Funneler
	AU10+23	Upper Lip Raiser and Lip Tightener
	AU17+23	Chin Raiser and Lip Tightener
	AU17+24	Chin Raiser and Lip Presser
Disgust	AU10	Upper Lip Raiser
	AU9+17	Nose Wrinkler and Chin Raiser
	AU10+17	Upper Lip Raiser and Chin Raiser
Fear	No AU was identified	



#### **4.2.2.5. Statistical Analysis**

SPSS version 22 was used to analyse the data. In order to test the mood induction, repeated measures ANOVA was used comparing pre-film and post-film PANAS (within-group) among the three groups (AN, BN, or HC; between-subject factor). Prior to conducting all analyses on facial emotion expression, distributions were examined to evaluate normality. Since data was not normally distributed, non-parametric tests were used. To evaluate difference in the proportion of participants who showed facial expressions of emotions in the 3 groups (AN, BN and HC) Chi square test of independence was used when possible (i.e. when more than 5 participants on each group exhibited facial expressions). Kruskal- Wallis test was conducted to investigate differences among the groups in duration and intensity of facial expressions of emotions. Effect sizes were calculated by using Rosenthal's  $r$  for non-parametric tests.

### **4.2.3. RESULTS**

#### **4.2.3.1. Demographics and Clinical Characteristics**

Participant's demographic and clinical characteristics are described in table 4.2. As expected, clinical participants differed from HC on measures of ED, anxiety, depression, and alexithymia. In addition, AN participants had lower BMI than BN and HC groups. There was no difference in the length of illness of AN and BN participants.

**Table 4.2. Demographics and clinical characteristics**

	AN (n=20)	BN (n=20)	HC (n=20)	AN vs BN	AN vs HC	BN vs HC
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>p (d)</i>	<i>p (d)</i>	<i>p (d)</i>
Age	28.85 (9.75)	27.20 (6.89)	26.40 (7.60)	0.80 (0.20)	0.61 (0.29)	0.95 (0.11)
Years of Education	16.79 (2.90)	16.35 (2.48)	18.20 (3.41)	0.89 (0.17)	0.30 (0.46)	0.13 (0.64)
BMI	15.59 (1.83)	22.00 (3.00)	22.47 (2.68)	<b>&lt;0.01</b> (2.65)	<b>&lt;0.01</b> (3.08)	0.83 (0.17)
Length of Illness	11.55 (11.26)	8.60 (6.79)	N/A	0.32 (0.33)	N/A	N/A
EDE-Q	4.38 (1.04)	3.87 (1.32)	0.48 (0.42)	0.25 (0.44)	<b>&gt;0.01</b> (5.05)	<b>&gt;0.01</b> (3.55)
HADS-A	13.15 (3.60)	12.00 (2.79)	5.95 (1.85)	0.41 (0.37)	<b>&gt;0.01</b> (2.58)	<b>&gt;0.01</b> (2.62)
HADS-D	10.60 (3.15)	9.65 (3.39)	3.85 (1.60)	0.54 (0.30)	<b>&gt;0.01</b> (2.77)	<b>&gt;0.01</b> (2.24)
TAS-20	60.45 (13.08)	55.50 (14.89)	34.75 (5.85)	0.39 (0.36)	<b>&gt;0.01</b> (2.6)	<b>&gt;0.01</b> (1.88)

AN= Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls; n= Number of participants; *M*= Mean; *SD*= Standard deviation; *p*= p-value; *d*= Cohen's *d* effect size; BMI= Body mass index; EDE-Q= Eating Disorders Examination questionnaire global score; HADS-A= Hospital Anxiety and Depression Scale- Anxiety scale; HADS-D= Hospital Anxiety and Depression Scale- Depression scale; TAS-20= Toronto Alexithymia Scale.  
 Bold indicates statistically significant difference ( $p < 0.01$ ).

#### **4.2.3.2. Mood induction**

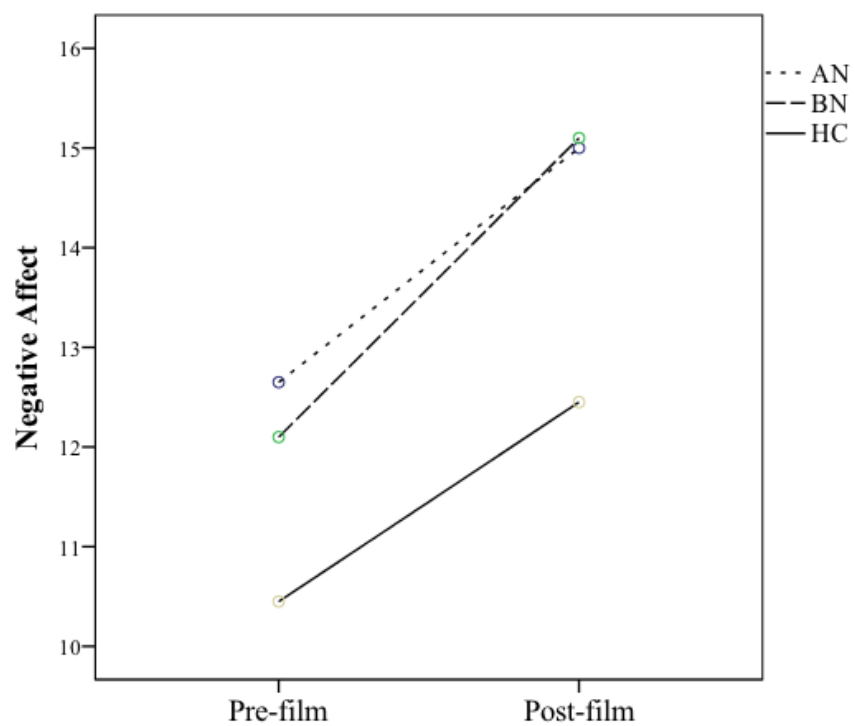
Pre-film and post-film PANAS were compared to test the extent to which the film had been able to produce a change in participants' affect. Means and standard deviations for all groups are shown in table 4.3. Results of repeated measures ANOVA indicated that there was a significant effect of film, with a significant increase in negative affect after viewing the film ( $F(1,57)= 28.26, p< 0.01$ ). There was no significant effect of group ( $F(2,57)=2.90, p=0.06$ ) and the group X film interaction was not significant ( $F(2,57)=0.40, p=0.67$ ), suggesting similar increase in positive affect in all groups after viewing the film clip (Figure 4.1).

**Table 4.3. Negative affect before and after the film**

Group	Pre-film Negative Affect <i>M (SD)</i>	Post-film Negative Affect <i>M (SD)</i>	Effect size Cohen's <i>d</i>
AN	12.65 (3.71)	15.00 (4.05)	0.62
BN	12.10 (2.65)	15.00 (6.23)	0.62
HC	10.45 (0.69)	12.45 (3.69)	0.77

*M*= Mean; *SD*= Standard deviation; AN= Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls.

**Figure 4.1. Changes in negative affect after the film**



AN=Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls.

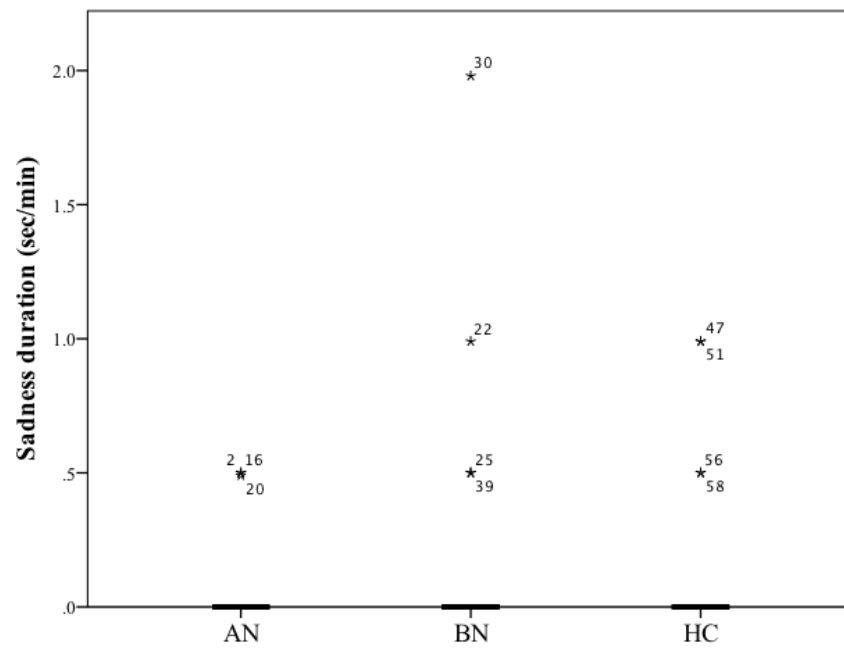
#### **4.2.3.3. Emotion expression**

##### *4.2.3.3.1. Facial expressions of sadness:*

First, facial expressions of sadness were explored. Results indicated that 3 participants with AN (15%), 4 with BN (20%) and 4 HC participants (20%) showed facial expressions of sadness whilst watching the film clip.

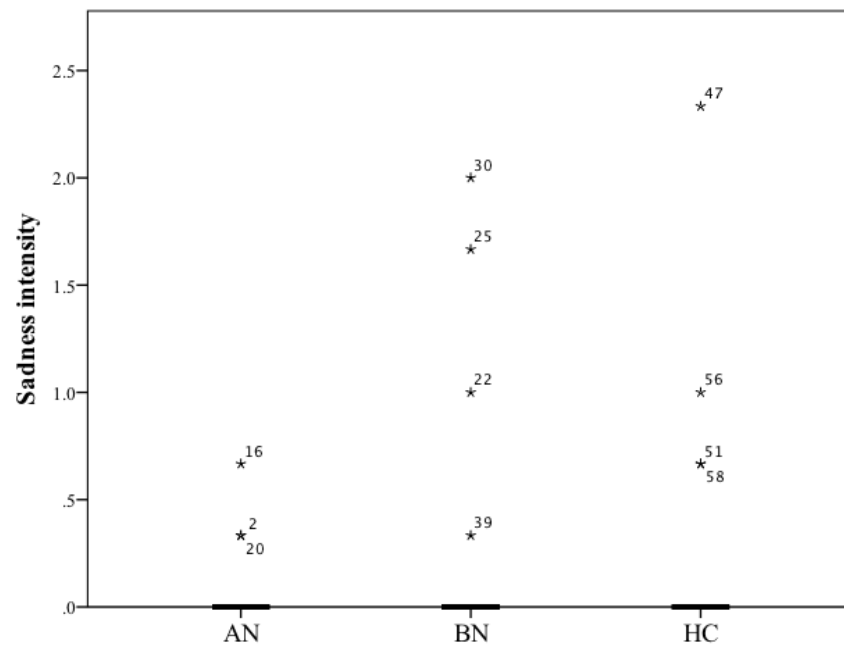
Figures 4.2 and 4.3 show median sadness duration and intensity for all groups. Results from Kruskal-Wallis test indicated that there were no statistically significant differences among the groups (Sadness duration:  $H(2)=0.43$ ;  $p=0.81$ ; Sadness intensity:  $H(2)=0.45$ ;  $p=0.80$ ) (Table 4.4).

**Figure 4.2. Sadness duration**



AN=Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls.

**Figure 4.3. Sadness intensity**



AN=Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls.

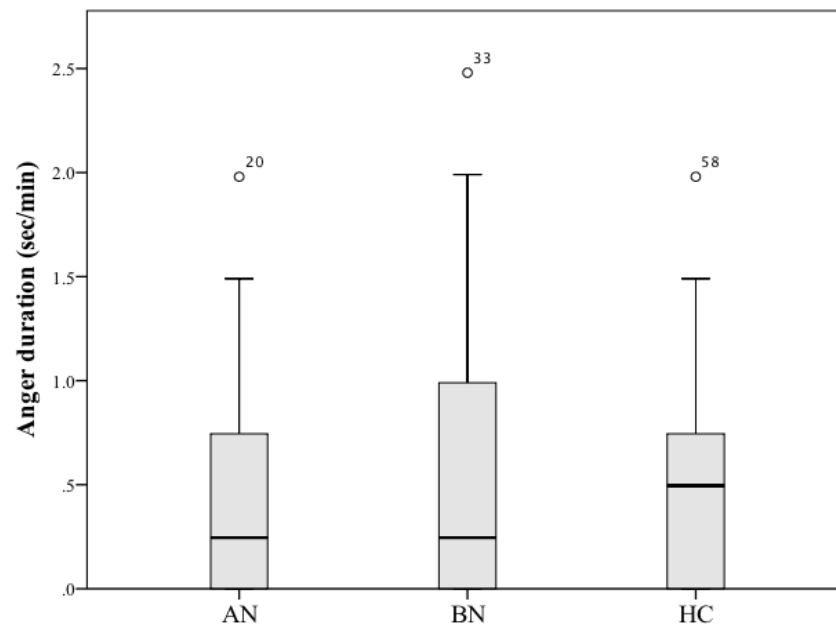


#### 4.2.3.3.2. *Facial expressions of anger:*

Results indicated that 50% of AN and BN participants (AN:  $n=10$ ; BN:  $n=10$ ) and 55% of HC ( $n=11$ ) exhibited facial expressions of anger. Chi square test indicated that the difference in proportion among the groups was not significant ( $\chi^2(2)=1.33$ ;  $p=0.94$ ).

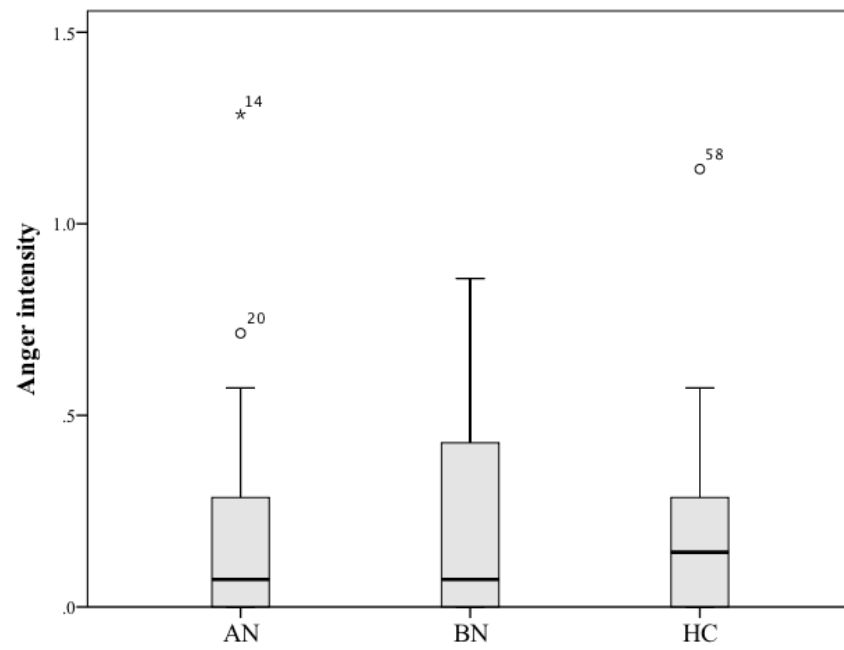
Median anger duration and intensity for all groups can be seen in figure 4.4 (duration), figure 4.5 (intensity) and table 4.4. Results from Kruskal-Wallis test revealed no statistically significant difference among the groups (Anger duration:  $H(2)=0.11$ ;  $p=0.95$ ; Anger intensity:  $H(2)=0.05$ ;  $p=0.98$ ).

**Figure 4.4. Anger duration**



AN=Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls.

**Figure 4.5. Anger intensity**



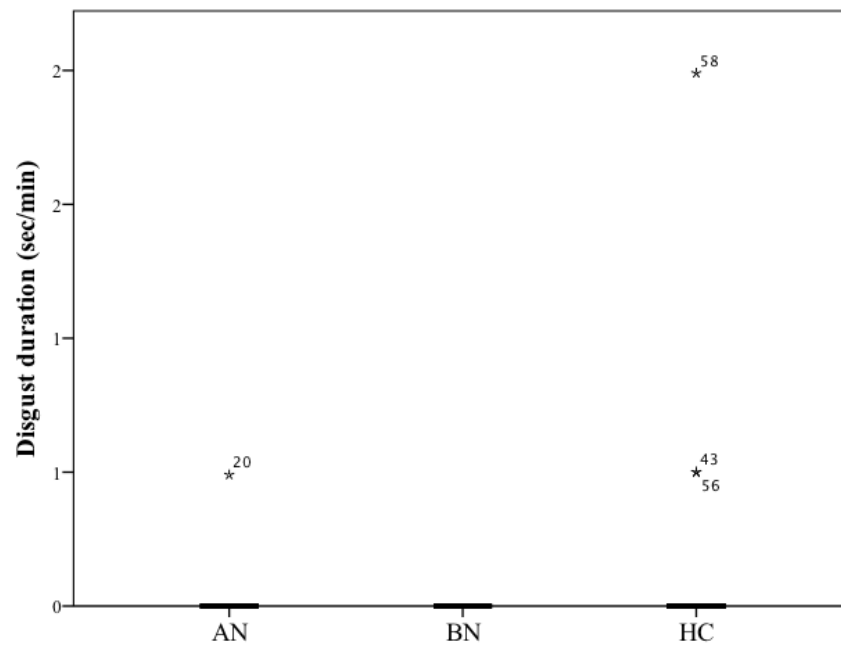
AN=Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls.

#### 4.2.3.3.3. *Facial expressions of disgust:*

One participants with AN (5%) and 3 HC participants (15%) showed facial expressions of disgust. No BN participant exhibited these expressions.

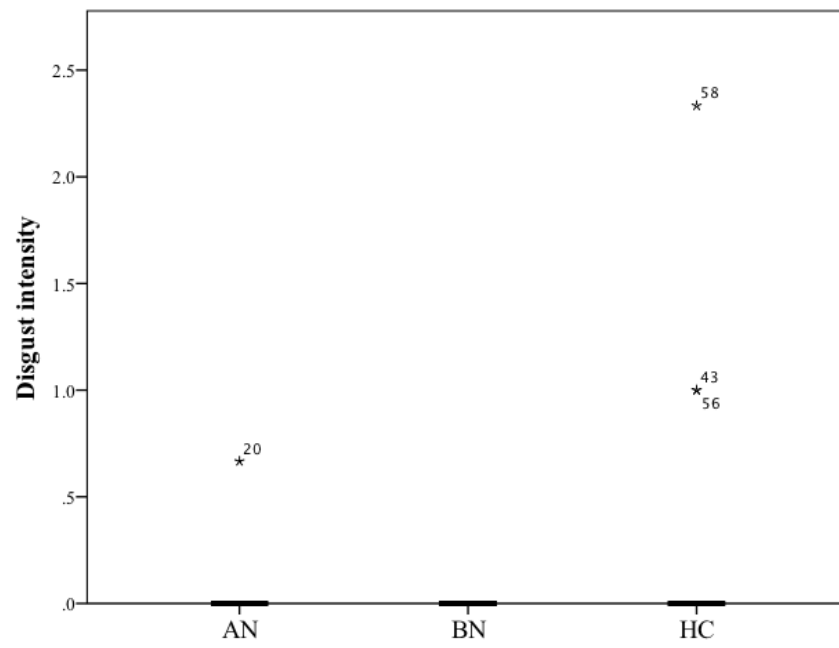
Median disgust duration and intensity for all groups is shown in figure 4.6 (duration), figure 4.7 (intensity) and table 4.4. Results from Kruskal-Wallis test showed no statistically significant difference among the groups (Disgust duration:  $H(2)=3.84$ ;  $p=0.15$ ; Disgust intensity:  $H(2)=3.84$ ;  $p=0.15$ ).

**Figure 4.6. Disgust duration**



AN=Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls.

**Figure 4.7. Disgust intensity**



AN=Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls.

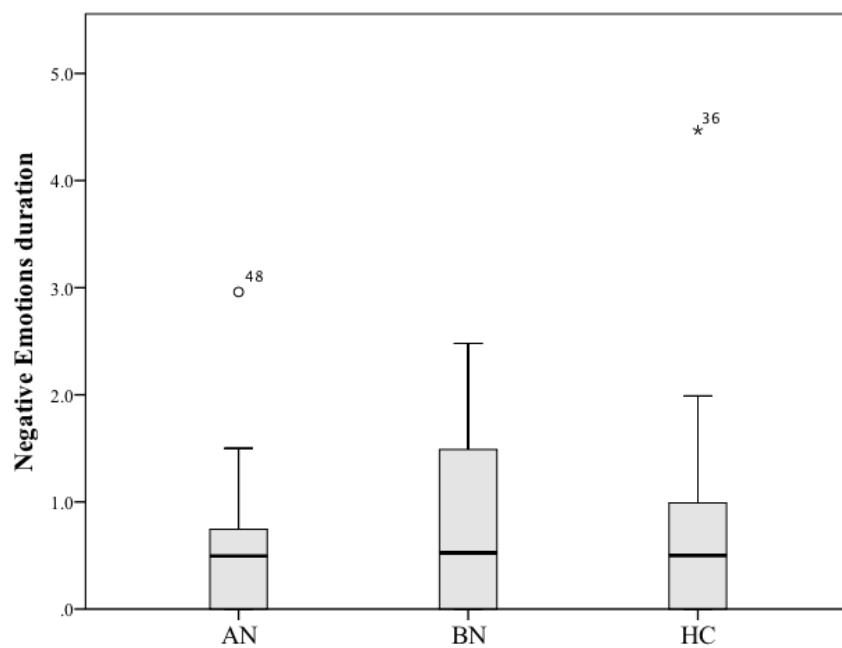
#### 4.2.3.3.4. *Facial expressions of negative emotions:*

Since a small number of participants exhibited facial expressions of some of the emotions analysed above (particularly for disgust and sadness), the duration and intensity of all facial expressions of anger, disgust and sadness were collapsed to explore differences in the expression of negative emotions.

Results indicated that 55% of participants with AN (n=11), 55% of BN (n=11) and 70% of HC participants (n=14) exhibited facial expressions of negative emotions whilst watching the clip. The difference in proportion among the groups was not significant ( $\chi^2(2)=1.25$ ;  $p=0.53$ ).

Median duration and intensity for expressions of negative emotions on each groups can be seen in figure 4.8 (duration), figure 4.9 (intensity) and table 4.4. Results from Kruskal-Wallis test revealed no statistically significant difference among the groups (Negative emotions duration:  $H(2)=0.86$ ;  $p=0.65$ ; Negative emotions intensity:  $H(2)=0.70$ ;  $p=0.70$ ).

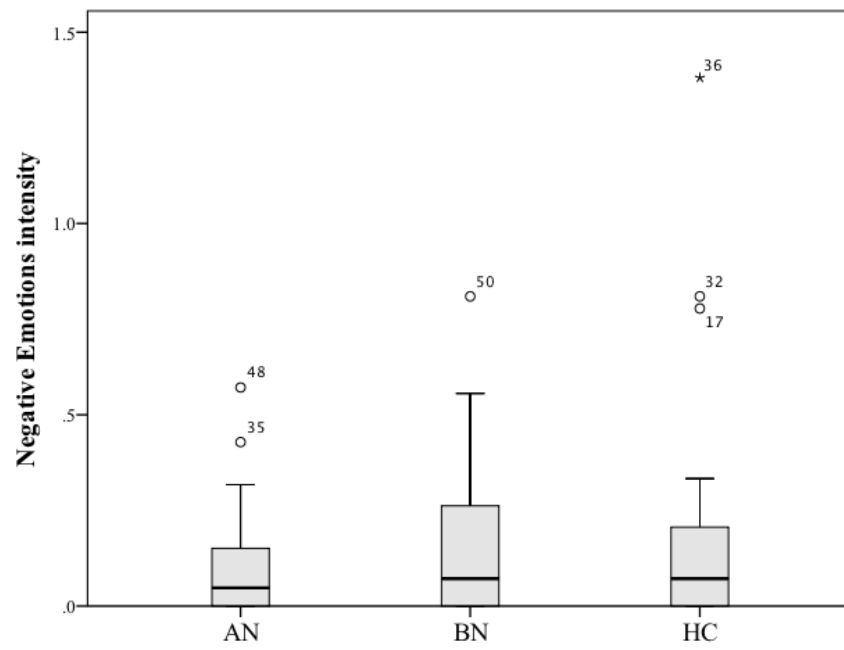
**Figure 4.8. Negative emotions duration**



AN=Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls.



**Figure 4.9 Negative emotions intensity**



AN=Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls.

**Table 4.4. Facial expression of negative emotions on each group**

	AN (n=20)		BN (n=20)		HC (n=20)		Group Comparison
	<i>M (SD)</i>	<i>Mdn (IQR)</i>	<i>M (SD)</i>	<i>Mdn (IQR)</i>	<i>M (SD)</i>	<i>Mdn (IQR)</i>	<i>H (p)</i>
Sadness duration	0.07 (0.18)	0.00 (0.00)	0.20 (0.49)	0.00 (0.00)	0.15 (0.33)	0.00 (0.00)	0.43 (0.81)
Sadness intensity	0.07 (0.17)	0.00 (0.00)	0.25 (0.59)	0.00 (0.00)	0.23 (0.57)	0.00 (0.00)	0.45 (0.80)
Anger duration	0.45 (0.58)	0.25 (0.87)	0.57 (0.74)	0.25 (0.99)	0.50 (0.60)	0.50 (0.87)	0.11 (0.95)
Anger intensity	0.23 (0.34)	0.07 (0.29)	0.22 (0.27)	0.71 (0.43)	0.20 (0.28)	0.14 (0.29)	0.05 (0.98)
Disgust duration	0.02 (0.01)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.15 (0.46)	0.00 (0.00)	3.84 (0.15)
Disgust intensity	0.03 (0.15)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.22 (0.59)	0.00 (0.00)	3.84 (0.15)
Negative Emotions duration	0.55 (0.75)	0.50 (0.87)	0.77 (0.87)	0.53 (1.49)	0.80 (1.04)	0.50 (0.99)	0.86 (0.65)
Negative emotions intensity	0.11 (0.16)	0.50 (0.17)	0.16 (0.22)	0.07 (0.27)	0.22 (0.36)	0.71 (0.21)	0.70 (0.70)

AN= Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls; n= Number of participants; *M*= Mean; *SD*= Standard deviation; *Mdn*= Median; *IQR*= Interquartile range; *H*=Kruskal-Wallis H test; *p*= p-value.

#### **4.2.3.4. Association of emotion expression and clinical characteristics.**

The analysis of associations of emotion expression and clinical characteristics was aimed at better understanding the characteristics of ED participants who exhibited reduced facial expression of negative emotions. Since AN and BN participants showed no differences in facial expression of negative emotions compared to HC, further associations with clinical characteristics were not tested.

### **3.2.4. DISCUSSION**

This study aimed to investigate facial expression of negative emotions in people with AN and BN compared to HC, by looking at their expression of four negative emotions (i.e., anger, disgust, fear, and sadness) in response to a film clip. Results indicated that in all groups a large number of participants did not exhibit facial expressions of these emotions whilst watching the film (30 to 45% of participants). Moreover, there were no statistically significant differences among the groups, showing no evidence of reduced facial expression of negative emotions in people with AN and BN, when compared to HC. These results do not support the study hypothesis and differ from the findings of previous studies in facial expression of negative emotions in people with ED (Cardi et al., 2015; Claes et al., 2012; Davies et al., 2011; Rhind et al., 2014; Tarrega et al., 2014).

Differences in the methodology used in this study could explain the divergent results. Even though the overall design of this study is very similar to Davies et al. (2011) and Rhind et al. (2014), a different coding system was employed to code facial expressions. The coding system used by these studies, FACES (Kring & Sloan, 1991), focuses on dimensions of positive/negative affect and provides ratings of overall facial changes according to the number of positive and negative facial expressions (Kohler, Hanson, & March, 2013). Instead, FACS (Ekman et al., 2002) focuses on specific actions produced in the face, rather than overall facial expressions. In this study, the specific action units

that are typical of discrete emotions were selected for analysis, ignoring other facial movements that have not been associated with discrete emotions (e.g., AU 43: Eyes closure). This kind of movements could have been interpreted as overall expressions and given a positive or negative valence in FACES, yielding different results.

Another difference is the outcome used in the studies. Even though FACES provides ratings for frequency, duration and intensity of expressions, studies have generally used frequency as a main outcome (Cardi et al., 2015; Davies et al., 2011; Rhind et al., 2014), whereas the current study uses duration and intensity as outcome measures. This could have translated into differences in results. For example, someone who shows several facial expressions of emotions for very short periods of time may have a high score if frequency is coded, but a small score if duration is considered. Likewise, someone who exhibits one facial expression during a long time may have a small score if frequency is the main outcome, but a high score on duration.

Contrary to Cardi et al. (2015), Davies et al. (2011) and Rhind et al. (2014) studies, Claes et al. (2012) and Tarrega et al. (2014) studies employ an automatic system to code facial expressions of anger. This system utilises facial tracking to detect and track the location of specific parts of the face (such as corners of the eyes and corners of the mouth), and provides the duration of angry facial movements as an outcome (Claes et al., 2012). Even though it is unclear which specific movements were considered to be specific of anger, it can be speculated that this system is more similar to the one used in this study. Thus, the use of FACS would not explain the different results among these studies. However, the differences could be explained by the different means of mood elicitation employed. Claes et al. (2012) and Tarrega et al. (2014) investigated facial expressions in response to a therapeutic video game, which has a more interactive nature than the film clip used in this study and could have produced stronger emotions in participants.

In fact, some of the study results may suggest that the film clip utilised did not produce a strong mood elicitation. The analysis of the proportion of participants who exhibited

facial expression of negative emotions showed that nearly a half of participants did not show facial expressions of negative emotions during the 2 minutes long film. In addition, even though there was a statistically significant increase in self-reported negative affect after the film, the actual increase was small (mean increase ranged between 2.00 to 2.90). Moreover, the mean scores of post film PANAS suggest that the intensity of negative emotions was low (mean scores for all groups ranged from 12.45 to 15.00, in a scale that ranges from 10.00 to 50.00). Overall, these data may suggest that the film was not able to induce strong negative emotions in the participants. Less intense negative emotions may have not reflected in participants' facial expressions.

Overall, the study results may suggest that facial expression of negative emotions in ED is very sensitive to the methodology employed to measure it, and the findings of previous studies are less robust than those of positive facial expressions (see study 4.1).

The study has some limitations. First, as mentioned above even though the film clip chosen for mood elicitation has been successful at eliciting negative affect in previous studies, results from this study suggest that it was not strong enough at inducing negative emotions in the participants. Future studies might consider complementing the film with the recall of autobiographic events in which the participant experienced the target emotion (e.g., Fox et al., 2013) in order to enhance the mood elicitation. Another limitation is the small sample size, which limited the study power to detect differences among groups. For example, in the current study the proportion of participants who exhibited facial expression of negative emotions was higher in HC than the ED groups (70% vs 55% for AN and BN). However, the difference was not statistically significant. This may be due to lack of power. Finally, it needs to be noted that the study was conducted on females only, and the results cannot be generalised to men with ED.

In conclusion, results from the current study do not support previous findings of reduced facial expression of negative emotions in ED. Differences in methodology might explain the differences in results, suggesting that the reduced facial expression of negative

emotions reported for ED participants in previous studies might be sensitive to study measurement.

## **CHAPTER 4**

### **STUDY 3**

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DELIBERATELY GENERATED AND IMITATED FACIAL  
EXPRESSION OF EMOTIONS IN PEOPLE WITH EATING DISORDERS

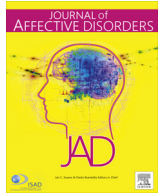
## **DELIBERATELY GENERATED AND IMITATED FACIAL EXPRESSIONS OF EMOTIONS IN PEOPLE WITH EATING DISORDERS**

Facial expression requires control when displaying affect (Williams et al., 2013). The ability to generate facial expressions intentionally and to imitate facial expressions of emotions is thought to be involved in the development of empathy, cooperation, and social relationships, playing a relevant role in socio-emotional development (Heyes, 2009). In this study, the ability to pose and imitate facial expressions of emotions is tested in women with AN, BN and HC. This is the first study to investigate posed and imitated facial expressions of emotions in ED.

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## Research report

## Deliberately generated and imitated facial expressions of emotions in people with eating disorders

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## ABSTRACT

**Background:** People with eating disorders have difficulties in socio emotional functioning that could contribute to maintaining the functional consequences of the disorder. This study aimed to explore the ability to deliberately generate (i.e., pose) and imitate facial expressions of emotions in women with anorexia (AN) and bulimia nervosa (BN), compared to healthy controls (HC).

**Methods:** One hundred and three participants (36 AN, 25 BN, and 42 HC) were asked to pose and imitate facial expressions of anger, disgust, fear, happiness, and sadness. Their facial expressions were recorded and coded.

**Results:** Participants with eating disorders (both AN and BN) were less accurate than HC when posing facial expressions of emotions. Participants with AN were less accurate compared to HC imitating facial expressions, whilst BN participants had a middle range performance. All results remained significant after controlling for anxiety, depression and autistic features.

**Limitations:** The relatively small number of BN participants recruited for this study.

**Conclusions:** The study findings suggest that people with eating disorders, particularly those with AN, have difficulties posing and imitating facial expressions of emotions. These difficulties could have an impact in social communication and social functioning. This is the first study to investigate the ability to pose and imitate facial expressions of emotions in people with eating disorders, and the findings suggest this area should be further explored in future studies.

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## 1. Introduction

Eating disorders (ED), such as anorexia (AN) and bulimia nervosa (BN), are characterised by disturbances in eating patterns and negative feelings about body shape and weight (American Psychiatric Association, 2013). In addition, people with ED often experience difficulties in the social domain (Caglar-Nazali et al., 2014), for example, reporting high levels of social anhedonia (Tchanturia et al., 2012) and avoidance of social rewards (Cardi et al., 2013). Moreover, eating disorder's detrimental impact on social relationships is the highest amongst all general functioning domains (Tchanturia et al., 2013a).

Non-verbal communication skills play an important role in overall social functioning and the maintenance of social

relationships (Blanchard and Panzarella, 1998). In particular, facial expressions of emotion are thought to enhance social functioning by conveying people's emotional experience, increasing feelings of affiliation and rapport (Ekman, 1992; Schmidt and Cohn, 2001) and also by communicating specific information (Fridlund, 1994). According to the latter view, facial expressions of emotion can be seen as communication tools, in which there is a deliberate intention to deliver a message to others (Fridlund, 1994).

Studies investigating spontaneous facial expression of emotions in people with AN consistently report that these patients show reduced facial expression of emotions, including those elicited through film clips (Davies et al., 2011; Rhind et al., 2014; Dapelo et al., 2015) and videogames (Claes et al., 2012). There is also preliminary evidence for reduced expression of anger in response to videogames in BN (Tarrega et al., 2014), but other studies have not found differences between people with BN and healthy controls (HC) (Claes et al., 2012).

The study of spontaneous facial expressions can provide

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information about the extent to which participants are able to convey their emotional experience. However, being unintentional, spontaneous facial expressions may not reflect a deliberate intention to deliver a message to others (Dethier et al., 2012). In contrast, it has been proposed that posed facial expressions (i.e., facial expressions that are deliberately generated), which are more regulated by cognitive control (Rinn, 1984), may reflect skills required when using facial expressions to communicate a message (Dethier et al., 2012).

Communicating information through facial expressions of emotions requires intentional control when displaying affect. It has been suggested that imitation plays a role in developing control over our facial expressions (Williams et al., 2013). Facial imitation (i.e., copying a model's facial expression) is thought to be involved in social development, empathy, cooperation, and social relationships (Heyes, 2009). In addition, imitation may contribute for facial expressions to be culturally shaped, enhancing social communication (Whiten et al., 1999).

Posed and imitated facial expressions of emotions have shown to be altered in people with schizophrenia and autism spectrum disorders (Faso et al., 2015; Kohler et al., 2008; Schwartz et al., 2006; Sevelever and Gillis, 2010). However, even though similarities in the social and cognitive domain have been reported for AN and autism spectrum disorders (Mandy and Tchanturia, 2015; Oldershaw et al., 2011b; Tchanturia et al., 2013b; Zucker et al., 2007), to date no study has investigated posed and imitated facial expression of emotions in this population.

In this context, the purpose of the study was to explore the ability to pose and imitate facial expressions of emotions in women with AN and BN, compared to a healthy control (HC) group. Given the evidence of reduced spontaneous facial expression in AN, we hypothesised that AN participants will show difficulties posing and imitating facial expressions of emotions. As the evidence for BN is more mixed, we hypothesised that they may exhibit a similar performance to the HC group.

## 2. Methods

### 2.1. Design

Cross-sectional, case-control study comparing three groups (two clinical groups, AN and BN, and HC) matched by age, on two experimental tasks (posed expressions task, and imitated expression task). The study was approved by the National Health Research Ethics Services Committee (13/LO/0201).

### 2.2. Participants

Participants were 103 women between the ages of 18 and 55 years: Thirty-six women with AN (17 restricting type, and 19 binge-eating/purging type), 25 with BN, and 42 HC. Participants with AN and BN were included in the study if they met DSM-5 criteria (American Psychiatric Association, 2013) for AN or BN diagnosis, respectively. This was assessed by the first author (MD) using the Structured Clinical Interview for DSM-IV-TR Axis I Disorders (SCID-I; First et al., 2002), along with measures of height and weight taken on the day of the assessment. A body mass index (BMI; kg/m<sup>2</sup>) less than 18.5 was required for AN diagnosis, whilst for BN diagnosis it was required a BMI above 18.5. Inclusion criteria for HC participants were having no history of ED assessed through the SCID-I, and a BMI above 18.5. Exclusion criteria for all participants were having a head injury, autism spectrum disorders, and psychosis, not being fluent in English, and being unable to provide informed consent. Clinical participants were recruited from specialist ED services, and through advertisement on the Beat

website (<http://www.b-eat.co.uk/>). The HC group was recruited from the local community. All participants signed informed consent prior to participate in the study.

### 2.3. Measures

#### 2.3.1. Body mass index (BMI)

Height and weight of participants were measured on the day of the assessment to calculate BMI.

#### 2.3.2. Structured Clinical Interview for DSM-IV-TR Axis I Disorders (SCID-I) (First et al., 2002)

The eating disorders module of the SCID-I was used to assess ED diagnosis in all participants. In order to allow for the main changes in diagnostic criteria introduced by DSM-5 (American Psychiatric Association, 2013), amenorrhea was not required for AN, and the frequency of binge eating and purging behaviour was reduced to once a week for BN.

#### 2.3.3. Demographic Questionnaire

This is a self-report survey with questions on age, treatment status and medication usage.

#### 2.3.4. Eating Disorder Examination Questionnaire (EDE-Q) (Fairburn and Beglin, 1994):

This is a widely used 36-item self-report measure that assesses cognitions and behavioural features of ED. The internal consistency for the EDE-Q global score in the current sample was  $\alpha=0.98$ .

#### 2.3.5. Hospital Anxiety and Depression Scale (HADS) (Zigmond and Snaith, 1983)

This 14-item self-report questionnaire has been shown to have adequate validity and reliability (Bjelland et al., 2002). Internal consistencies in the current study were  $\alpha=0.74$  for the anxiety scale, and  $\alpha=0.71$  for the depression scale.

#### 2.3.6. Autism Quotient (AQ-10) (Allison et al., 2012)

The AQ-10 is the shorter version of the original AQ (Baron-Cohen et al., 2001), used to assess autistic features. In this study the internal consistency was  $\alpha=0.63$ .

### 2.4. Tasks

#### 2.4.1. Posed expressions task

During the posed expression task participants were asked to generate a facial expression for five emotions (anger, disgust, fear, happiness, and sadness) in response to a verbal instruction. Participants sat in front of a computer laptop with a built-in camera and were asked to “pose or show the computer a facial expression for ‘X’ (i.e., anger, disgust, fear, happiness, or sadness)”. Participants were asked to look straight at the camera to indicate the moment when they thought they were posing the facial expression at their best. First, the investigator posed the emotion ‘surprise’ as an example, and checked if the participant had understood the instructions. Then, participants attempted to pose the facial expressions for all five emotions (order was random), under the researcher’s (MD) instruction. The researcher did not look at the participants whilst they were performing the task.

#### 2.4.2. Imitated expressions task

During this task participants were asked to imitate five facial expressions of emotions. The facial expressions were taken from the Pictures of Facial Affect set of prototypical facial expressions for emotions (Ekman and Friesen, 1976). Three randomisation lists with pictures of female faces displaying anger, fear, disgust,

happiness and sadness in random order were made. Each participant was assigned to one randomisation list. The pictures with the model's facial expressions were presented in a computer laptop screen, one at a time, and in turn the participants were asked to imitate the model's facial expression the best they could. As in the posed emotions task, they were instructed to look at the camera to indicate when they were best imitating the facial expression.

The tasks are based on Schwartz and collaborators' study of posed and imitated emotion expressions (Schwartz et al., 2006).

## 2.5. Procedures

Participants attended one testing session, in which experimental and self-report measures were carried out. Participants obtained £10 to compensate for their time. The first author (MD) was responsible for data collection.

## 2.6. Scoring of the facial expressions

All video records were inspected by MD, and pictures were taken at the moment participants looked straight at the camera. Another researcher who was blind to participants' diagnosis and study hypothesis (SB) scored all pictures in both tasks. Twenty-five percent of the pictures were also rated by MD and inter-rater reliability of scoring was assessed using intra-class correlation coefficient. Intra-class correlation analysis was chosen because it is more suitable for ordinal data than Cohen's kappa statistic (Banerjee et al., 1999).

The posed expressions task was scored in two stages. On the first stage (i.e., 'Recognisability'), the researcher blind to study hypothesis was asked to judge which emotion was being portrayed by the participant, in a forced choice paradigm (options were: anger, disgust, fear, happiness, and sadness). The rater based his judgment in descriptions of typical facial features for each emotion taken from Ekman and Friesen (2003). In addition, in order to ensure the rater's proficiency at recognising emotions in facial expressions, his ability was tested using an emotion recognition task, in which he obtained near perfect scores (98% accuracy).

The rater's judgement was compared to the emotion the participant was instructed to portray to assess the recognisability of the participant's facial expression. For example, if a participant was instructed to pose 'anger' and the rater estimated that her facial expression looked 'angry', the facial expression was deemed 'recognisable'. On the other hand, if the rater estimated the facial expression looked 'sad' (or 'fearful', or 'happy', or 'disgusted') it was considered 'not recognisable'. Participants' count of recognisable expressions for all 5 emotions was added to form a total score ranging from 0 to 5.

On the second stage ('Accuracy'), the accuracy of all recognisable expressions was assessed. For this purpose, a guideline was developed, which included descriptions of typical facial features for each emotion taken from Ekman and Friesen (2003). For example, in the guideline 'anger' was described with the following key features: eyebrows lowered and drawn together, eyelids tensed, lips tightly pressed together or parted in a squared shape showing the teeth. In addition, the guideline included 3 pictures of angry faces taken from Ekman and Friesen (2003). For the accuracy assessment, expressions were evaluated comparing their features to the description and pictures provided in the guideline. The rater determined the expression accuracy using a 6-point Likert scale (i.e., 1: 'Not at all accurate', 2: 'Barely accurate', 3: 'Somewhat accurate', 4: 'Reasonably accurate', 5: 'Mostly accurate', and 6: 'Perfectly accurate') aided by descriptions for each anchor point (e.g., 3: 'Somewhat accurate': The emotion showed is

confusing, but it can be identified. Some characteristic features are present, but they are not enough to avoid hesitation; 5: 'Mostly accurate': Most of the characteristic features are present and accurately shown, and the emotion can be clearly identified. However, some features are still missing or are shown slightly inaccurately).

Facial expressions that were deemed 'not recognisable' on stage one, obtained a score of 1 in the second stage. The score obtained on each emotion was added for a total accuracy score, ranging from 5 to 30. In order to estimate inter-rater reliability, 129 pictures (25%) were scored by both raters (MD, SB) and single measures intra-class correlation analysis was carried out, with satisfactory results (ICC (2,1)=0.80).

The imitated expression task was scored in a similar fashion to the second stage of the posed expressions task. A computer display presentation was created showing pairs of pictures on each view (i.e., the model's facial expression and the participant's imitation of the model). The researcher blind to study hypothesis (SB) was asked to rate how well the imitated facial expression matched the model, using a 6-point Likert scale (i.e., 1: 'No match at all', 2: 'Barely accurate match', 3: 'Somewhat accurate match', 4: 'Reasonably accurate match', 5: 'Mostly accurate match', and 6: 'Perfect match'). For this purpose, a guideline was built with descriptions for each anchor point (e.g., 2: 'Barely accurate match': one or 2 features of the model are present, but they are clearly insufficient to establish clear correspondence between the model and the imitated expression; 4: 'Reasonably accurate': it is possible to establish a clear correspondence between the model and the imitated expression. Nevertheless, the features showed in the imitated expression are too imprecise or inaccurate to be categorised as a good match). The score obtained on each imitated expression was added for a total imitation score, ranging from 5 to 30. In order to estimate inter-rater reliability, 129 pictures (25%) were scored by both raters and single measures intra-class correlation analysis was carried out, showing satisfactory reliability (ICC (2,1)=0.85).

## 2.7. Data analysis

Data were analysed using SPSS 21 (IBM Corp ©). Distributions were assessed using normality tests (i.e., Kolmogorov–Smirnov and Shapiro–Wilk tests) and when data were normally distributed, parametric tests were used. ANOVA with Gabriel's pairwise post-hoc test was used to identify differences in the mean performance of participants with AN, BN, and HC on the posed and imitated expression tasks. Gabriel's post-hoc test was selected because it shows adequate power when used with groups of different sample sizes (Field, 2013). Cohen's *d* effect size was calculated. When data were not normally distributed, non-parametric Kruskal–Wallis test was used instead. When differences between the ED groups and HC were found, multiple linear regression was used to control for potential confounders (i.e. anxiety, depression, and autistic features). Each of the potential confounding variables was tested individually in a separate linear regression model. The variables that were found to be individually associated with the outcome at *p*-values less than 0.05 were included in the multiple regression model. To explore the effect of medications in posed and imitated facial expression, ED participants were split into clinical participants who were taking medications (*n*=29) and those who were not (*n*=32) and an independent sample *t*-test was used. Finally, the association of clinical characteristics (i.e., BMI, length of illness, and ED features) and posed and imitated facial expression was explored within the ED group using the Pearson correlation coefficient.

### 3. Results

One hundred and three women participated in the study: 36 with AN, 25 with BN, and 42 HC. Average age for the whole sample was 27 years (SD=7.54). Participants' demographic and clinical characteristics can be seen in Table 1. As expected, participants with ED differed from HC on measures of eating disorder, anxiety, depression, and autistic features. Participants with AN had significantly lower BMI than those with BN and HC. There was no significant difference in the length of illness of AN and BN participants.

The majority of AN participants were receiving inpatient treatment at the time of the study ( $n=15$ ; 42%), followed by outpatient ( $n=9$ ; 25%), intensive outpatient ( $n=8$ ; 22%), or self-help treatment ( $n=1$ ; 3%). BN participants were receiving outpatient treatment ( $n=11$ ; 44%), self-help ( $n=2$ ; 8%), or intensive outpatient treatment ( $n=1$ ; 4%). Three AN participants (8%) and 11 BN participants were not receiving treatment (44%).

Sixty one percent of AN ( $n=22$ ) and 28% of BN participants ( $n=7$ ) were using psychotropic medications. In most of the cases, participants were using selective serotonin reuptake inhibitors (SSRI) (AN:  $n=17$ ; BN:  $n=5$ ). None of the HC participants was taking psychotropic medications.

#### 3.1. Posed expression

##### 3.1.1. Recognisability

Analyses of variance results are shown in Table 2. Since data were not normally distributed, Kruskal–Wallis test was carried out. Results indicated that there were no significant differences in posed expression recognisability among the groups.

##### 3.1.2. Accuracy

Fig. 1 shows descriptive results for all groups for posed emotion accuracy. Analyses of variance revealed that the groups differed significantly in accuracy (Table 2). Post-hoc tests indicated that both AN and BN participants were significantly less accurate than the HC group and there was no significant difference between the AN and BN participants.

In order to control for potential confounders, AN and BN participants were grouped together ( $n=61$ ) and multiple regression analysis was conducted, controlling for the effects of anxiety

(HADS-A), depression (HADS-D), and autistic features (AQ-10). Results indicated that having an ED remained as a significant predictor of posed emotion accuracy after controlling for all confounders (Table 3).

In addition, the effect of medication on accuracy was explored. For this purpose, ED participants who were using psychotropic medications ( $n=29$ ) were compared to those who were not ( $n=32$ ). Results indicated that there were no significant differences between both groups ( $t(59)=-0.39$ ;  $p=0.70$ ).

Finally, the association of clinical characteristics such as BMI, length of illness, eating disorder features (EDE-Q) and posed emotion accuracy was explored within the ED group. Results showed no statistically significant correlation between the variables (BMI:  $r=0.05$ ;  $p=0.73$ ; length of illness:  $r=0.04$ ;  $p=0.79$ ; EDE-Q:  $r=-0.06$ ;  $p=0.65$ ).

#### 3.2. Imitation

Descriptive results for all groups on imitation are shown in Fig. 2. Results of ANOVA showed significant differences in imitation among the groups (Table 2). Post-hoc tests indicated that AN participants had significantly lower performance than the HC group. Participants with BN did not differ from AN or HC participants, exhibiting middle scores.

In order to explore the extent to which being AN would remain a significant predictor of imitation after controlling for confounders, multiple regression analysis was conducted controlling for the effects of anxiety (HADS-A), depression (HADS-D), and autistic features (AQ-10). Results indicated that being AN remained as a significant predictor of imitation after controlling for all confounders (Table 3).

In addition, the performance of ED participants who were using psychotropic medications ( $n=29$ ) was compared to those who were not ( $n=32$ ). Results indicated that there were no significant differences between both groups ( $t(59)=-0.86$ ;  $p=0.39$ ).

Finally, the association of clinical characteristics such as BMI, length of illness, eating disorder features (EDE-Q) and imitation was explored within the ED group. Results indicated that BMI was significantly associated with imitation (BMI:  $r=0.26$ ;  $p=0.04$ ). There were no other statistically significant correlations between the variables (length of illness:  $r=0.04$ ;  $p=0.77$ ; EDE-Q:  $r=-0.15$ ;  $p=0.26$ ).

**Table 1**  
Participant's demographic and clinical characteristics.

	AN ( $n=36$ )	BN ( $n=25$ )	HC ( $n=42$ )	Group statistics	Post-hoc test		
	<i>M</i> ( <i>SD</i> )	<i>M</i> ( <i>SD</i> )	<i>M</i> ( <i>SD</i> )		AN vs. BN	AN vs. HC	BN vs. HC
Age	27.50 (8.24)	26.32 (6.64)	26.98 (7.55)	$F(2, 100)=0.18$ $p=0.84$	N/A	N/A	N/A
BMI	15.34 (1.72)	21.74 (2.94)	22.53 (4.10)	$F(2, 100)=94.66$ $p<0.01$	$p<0.01^{**}$ $d=2.83$	$p<0.01^{**}$ $d=2.26$	$p=0.49$ $d=0.22$
Length of illness (years)	10.53 (9.03)	7.56 (6.58)	N/A	$t(59)=1.40$ $p=0.17$ $d=0.37$	N/A	N/A	N/A
EDE-Q	4.24 (1.19)	4.01 (1.28)	0.56 (0.49)	$F(2, 100)=163.46$ $p<0.01$	$p=0.76$ $d=0.19$	$p<0.01^{**}$ $d=4.22$	$p<0.01^{**}$ $d=4.03$
HADS-A	13.56 (3.36)	12.16 (2.84)	5.79 (1.96)	$F(2, 100)=88.38$ $p<0.01$	$p=0.15$ $d=0.45$	$p<0.01^{**}$ $d=2.92$	$p<0.01^{**}$ $d=2.78$
HADS-D	10.24 (3.50)	9.40 (3.51)	3.74 (1.29)	$F(2, 100)=60.41$ $p<0.01$	$p=0.57$ $d=0.24$	$p<0.01^{**}$ $d=2.58$	$p<0.01^{**}$ $d=2.43$
AQ-10	4.22 (2.18)	3.60 (1.38)	1.48 (1.21)	$F(2, 100)=29.35$ $p<0.01$	$p=0.38$ $d=0.33$	$p<0.01^{**}$ $d=1.61$	$p<0.01^{**}$ $d=1.69$

AN=anorexia nervosa; BN=bulimia nervosa; HC=healthy control;  $n$ =number of participants;  $M$ =mean;  $SD$ =standard deviation;  $F$ =ANOVA test; N/A=non-applicable; BMI=body mass index;  $p$ = $p$ -value;  $d$ =Cohen's  $d$  effect size test; EDE-Q=Eating Disorders Examination Questionnaire; HADS-A=Hospital Anxiety and Depression Scale, Anxiety Subscale; HADS-D=Hospital Anxiety and Depression Scale; AQ-10: Autism Quotient.

\*\*  $p$ -value is significant  $<0.01$ .

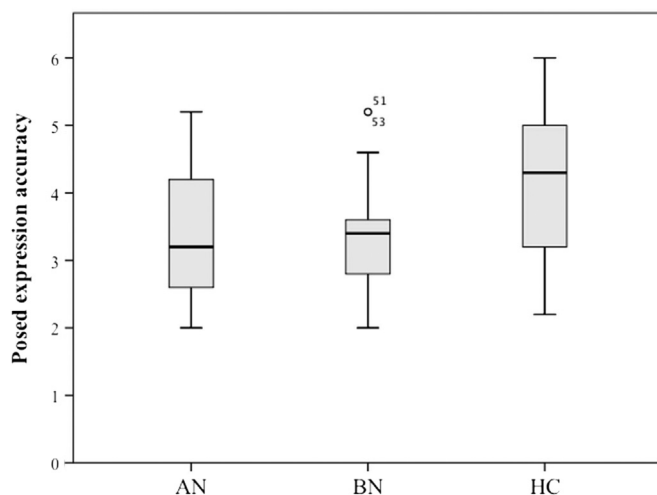


**Table 2**  
Group comparison on posed expressions and imitation task.

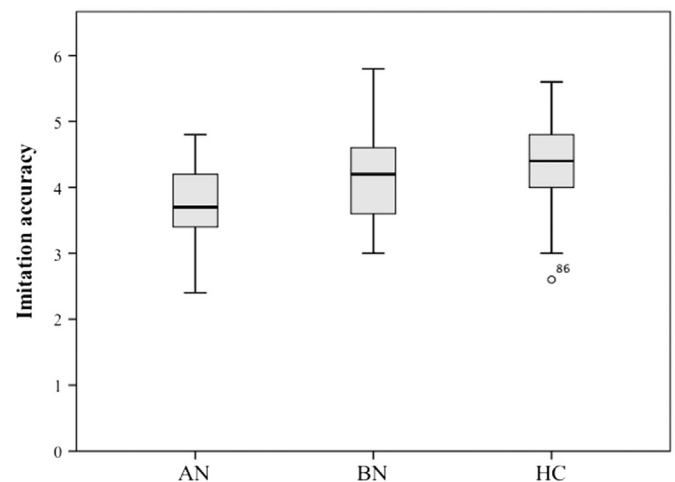
	AN (n=36)	BN (n=25)	HC (n=42)	Group statistics	Post-hoc test		
	M (SD)	M (SD)	M (SD)		AN vs. BN	AN vs. HC	BN vs. HC
Posed expressions recognisability	3.67 (0.99)	3.52 (0.92)	4.00 (0.91)	$H(2)=4.91$ $p=0.09$	N/A	N/A	N/A
Posed expressions accuracy	3.34 (0.93)	3.34 (0.87)	4.12 (1.08)	$F(2, 100)=7.80$ $p<0.01$	$p=1.00$ $d=0.00$	$p<0.01^{**}$ $d=0.78$	$p<0.01^{**}$ $d=0.79$
Imitation	3.74 (0.64)	4.09 (0.68)	4.31 (0.68)	$F(2, 100)=7.16$ $p<0.01$	$p=0.14$ $d=0.54$	$p<0.01^{**}$ $d=0.87$	$p=0.44$ $d=0.33$

AN=anorexia nervosa; BN=bulimia nervosa; HC=healthy control; n=number of participants; M=mean; SD=standard deviation; F=ANOVA test; N/A=non-applicable; BMI=body mass index; p=p-value; d=Cohen's d effect size test.

**\*\*** p-value is significant < 0.01.



**Fig. 1.** Posed emotion accuracy. Note: 51 and 53 represent outlier values. These data were included in the analysis.



**Fig. 2.** Imitation accuracy. Note: 86 represents an outlier value. This data was included in the analysis.

**Table 3**  
Multiple regression testing the effect of the eating disorder on posed expression and imitation accuracy, when controlling for comorbidities.

	B	SE B	t	p
DV: Posed expressions accuracy				
Constant	4.07	0.26	15.61	< 0.01
ED Dg	−0.80	0.35	−2.29	0.02*
HADS-A	0.03	0.04	0.68	0.50
HADS-D	−0.01	0.04	−0.20	0.84
AQ-10	−0.05	0.06	−0.77	0.45
DV: Imitation				
Constant	4.42	0.17	26.08	< 0.01
AN Dg	−0.35	0.17	−2.06	0.04*
HADS-A	−0.02	0.02	−0.95	0.35
HADS-D	0.02	0.03	0.57	0.57
AQ-10	−0.04	0.04	−0.84	0.40

B=unstandardized beta; SE B=standard error of beta; t=t-test, p=p-value, DV=dependent variable; ED Dg=eating disorders diagnosis; HADS-A=Hospital Anxiety and Depression Scale, Anxiety Subscale; HADS-D=Hospital Anxiety and Depression Scale; AQ-10: Autism Quotient; AN Dg=anorexia nervosa diagnosis.

\* p-value is significant < 0.05.

#### 4. Discussion

This study aimed to explore the ability to pose and imitate facial expressions of emotions in women with ED, comparing their performance to women without present or past history of eating disorders. The overall findings suggest that participants with ED, particularly those with AN, have difficulties posing and imitating facial expressions. These results are in line with our prediction that

the AN group will perform worse than the HC group in the both emotion expression tasks.

The analysis of recognisability of posed facial expressions of emotions showed no differences between participants with ED and HCs. However, the analysis of accuracy revealed that people with ED were less able to accurately show the prototypical features of emotions when posing facial expressions of emotions. The fact that ED participants' facial expressions were recognisable by a researcher blind to diagnostic status (despite not being very accurate), may suggest that patients' difficulties communicating emotions to others are subtle. Relative to deliberately generated (posed) emotion expressions, real-life facial expressions tend to be less exaggerated, which decreases their recognisability (Faso et al., 2015). In addition, people with ED tend to have limited social skills and low assertiveness (Arcelus et al., 2013; Hambrook et al., 2012); thus, even subtle difficulties in the ability to convey emotional messages might have an impact on social functioning in this population (Doris et al., 2014; Tchanturia et al., 2013a).

Participants with AN were the least accurate imitating prototypical facial expressions of emotions. These findings are in line with evidence of studies on spontaneous (automatic) facial expression of emotions that reported reduced facial expressions in AN (Davies et al., 2011; Rhind et al., 2014; Dapelo et al., 2015). It has been proposed that imitation is one mechanism by which people develop the ability to express emotions (Whiten et al., 1999; Williams et al., 2013). Thus, difficulties in imitation might contribute to the reduced facial expressivity found in AN. Future studies investigating the impact of imitation on spontaneous expressions would contribute to exploring this idea further.

To be able to imitate other people's facial expression it is

required to understand the intention of the person displaying the emotion (Tomasello et al., 1993). In this context, imitation requires the ability to mentalise or ascribe intentions and meaning to people's behaviour (Skarderud, 2007). People with AN have shown difficulties in emotion theory of mind (Oldershaw et al., 2011a, Russell et al., 2009) and these difficulties could be at the base of the problems in imitation seen in the current study. Future studies assessing mentalising abilities and imitation may explore the link between these two processes in people with AN.

Participants with BN obtained middle scores in the imitation task. Several reasons might explain the differences found between AN and BN. First, even though both disorders share core psychopathological aspect such as aberrant eating behaviour and negative feelings about shape and weight, they differ on BMI. Within the ED group, BMI was directly correlated with imitation in this study, and low BMI has been associated with reduced facial expression of emotions in AN (Davies et al., 2013; Dapelo et al., 2015). It could be speculated that BMI might affect facial expressivity in general, thus interfering with imitation of facial expressions. Alternatively, differences in the imitation task could relate to other differences in the current study's AN and BN sample. For example, whereas most of the AN participants were recruited from inpatient treatment programmes, most BN in this study were from outpatient programmes or were not receiving treatment. This suggests that BN participants in this study tended to live in the community, have employment or were students, and their general functioning was less affected by the ED. However, it should be noted that length of illness was similar for both groups. Finally, the relatively small number of BN participants could have resulted in reduced power to assess differences in this group.

The multiple regression analysis findings suggest that in people with ED, the difficulties posing and imitating facial expressions of emotions are explained mainly by the ED, and not comorbidities, such as anxiety, depression and autistic features. Comparison between medicated and un-medicated ED participants also suggests that posing and imitating facial expressions is not affected by psychotropic medications in this clinical group.

It has been proposed that problems in socio emotional processing may contribute to the maintenance of the ED (Treasure et al., 2012). According to this view, ED cognitions and behaviours can provide a distraction from emotions that are difficult to manage (Schmidt and Treasure, 2006). There is evidence that people with ED have difficulties regulating emotions (Harrison et al., 2010), and some new empirically informed treatments attempt to help patients regulating their emotions (e.g. Tchanturia et al., 2014, 2015). In this context, the problems in the ability to pose and imitate facial expressions of emotions reported in this study could interfere with the ability of patients to communicate their needs to clinicians and significant others, receiving less support as a consequence. In addition, the abilities involved in posing and imitating emotions are relevant for communication (Dethier et al., 2012), and social functioning (Heyes, 2009), which is particularly affected by the ED (Tchanturia et al., 2013a, Harrison et al., 2014). Thus, the difficulties shown by ED participants in this study underline the need to further investigate these processes, in order to inform treatments with focus on emotion processing, such as Cognitive Remediation and Emotional Skills Training (CREST) (Tchanturia et al., 2014), Emotion Acceptance Behaviour Therapy (EABT) for Anorexia Nervosa (Wildes et al., 2014), Radically Open-Dialectical Behaviour Therapy (RO-DBT) (Lynch et al., 2013); and the Maudsley Model of Anorexia Nervosa Treatment for Adults (MANTRA) (Schmidt et al., 2012) and with focus on mentalising abilities, such as Mentalisation Based Therapy for Eating Disorders (MBT-ED) (Robinson et al., 2014).

There are some limitations in this study we would like to highlight, for example, even though the researcher rating the facial

expressions was blind to the group allocation of the participants, some AN participants were visibly underweight and therefore their group allocation may have been revealed. In addition, the rating system used in this study does not inform about the clinical value of the differences found between ED participants and HC. Future studies could aim at investigating the clinical implications of these difficulties.

Another limitation of the study is the relatively small number of participants with BN, which could have impacted the results due to lack of power.

In conclusion, the study findings suggest that people with ED, particularly those with AN, have difficulties posing and imitating facial expressions, and that these difficulties are not explained by comorbid anxiety, depression, autistic features, or by the use of medication. These difficulties may be linked to problems in social functioning in this population. To our knowledge this is the first study looking at posed and imitated facial expressions of emotions in eating disorders and its findings suggest that this new area of study warrants further exploration.

### Contributor's statement

MD designed the study with the supervision of KT and RM. MD recruited the participants, collected the data and conducted statistical analyses. SB rated the experimental tasks. MD wrote the first draft of the manuscript, with the collaboration of SB. RM and KT critically reviewed the manuscript. All authors contributed and have approved the final manuscript.

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### Ethics

The study was approved by the National Health Research Ethics Services Committee (13/LO/0201).

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## CHAPTER 5

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### DISCUSSION



## **OVERVIEW**

This thesis consists of a series of empirical studies aimed at improving our understanding of emotion processing in individuals with ED. Specifically, three studies were conducted to investigate emotion recognition (study 3.1, 3.2, and 3.3) and three studies to investigate emotion expression in people with ED (study 4.1, 4.2, and 4.3).

This final chapter summarises the key study findings and synthesises them with the existing literature. The implications, strengths and limitations of the studies will be considered, followed by a discussion of future directions and the overall conclusions.

## DISCUSSION

### 5. 1. EMOTION RECOGNITION

#### 5.1.1. Summary of study findings

##### *5.1.1.1. Study 3.1: Emotion recognition in blended facial expressions in women with AN.*

The study investigated the ability to recognise emotions in blended facial expressions in adult women with AN, compared to a matched HC group.

Findings on recognition accuracy indicated difficulties recognising disgust, when displayed in less ambiguous facial expressions, which was commonly misinterpreted as anger. There were no differences between the groups on recognition accuracy for other emotions.

Results from the response bias analysis showed evidence of response bias towards anger in less ambiguous facial expressions. There were no other differences between participants with AN and HC.

A secondary objective of the study was to explore the role of BMI, length of illness, depression, obsessive-compulsive symptoms, medications, and alexithymia concerning poor facial emotion recognition in AN. Results indicated that none of these clinical characteristics was associated with poor disgust recognition.

The results of the study suggest that overall, people with AN do not have major problems recognising emotions in faces, but there are some difficulties specific to disgust and anger.

*5.1.1.2. Study 3.2: Exploring emotion recognition in adults and adolescents with AN using a body motion paradigm.*

The study investigated emotion recognition through body movement in adolescents and adults with AN, compared to HC.

The results indicated that participants with AN had difficulties recognising sadness, often misinterpreting it as neutral. There were no differences between the groups on the recognition of other emotions.

It was evidenced that younger participants with AN showed poorer recognition of sadness. Further exploration indicated that adolescents with AN showed more difficulties in sadness recognition, compared to adults.

Sadness recognition was not associated with clinical characteristics, such as BMI, anxiety, depression, or autistic traits.

The results of the study suggest that adolescents with AN may have difficulties recognising sadness in body movements.

*5.1.1.3. Study 3.3: Emotion recognition in faces and body movements in women with BN.*

The study investigated emotion recognition from facial expression and body movement in women with BN, compared to HC.

The results on emotion recognition in facial expressions showed that BN participants had difficulties recognising disgust, when displayed in less ambiguous facial expressions, and tended to misinterpret it as anger. Results from the response bias analysis revealed that BN participants had a response bias towards anger in less ambiguous facial expressions. There were no other differences between BN and HC participants.

There were no association between clinical characteristics (i.e., length of illness, eating disorder features, medication, anxiety, depression, and alexithymia) and disgust recognition.

The results for emotion recognition in body movement indicated that participants with BN did not differ from HC in their ability to recognise emotions from body movements.

The study results suggest that overall, people with BN do not have major problems recognising emotions in faces or body movements. However, they exhibit minor difficulties recognising disgust and a bias towards anger.

### **5.1.2. Synthesis with existing literature**

#### *5.1.2.1. Emotion recognition from facial expressions (Aim 1)*

The aim 1 of this thesis was to investigate emotion recognition in blended facial expressions of emotions in people with ED. Previous literature on facial emotion recognition in ED had yielded mixed finding. A few studies had found difficulties recognising all basic emotions (Jansch, Harmer, & Cooper, 2009; Zonnevillle-Bender, van Goozen, Cohen-Kettenis, van Elburg, & van Engeland, 2002), whilst others had reported no difficulties (Kessler, Schwarze, Filipic, Traue, & von Wietersheim, 2006; Mendlewicz, Linkowski, Bazelmans, & Philippot, 2005). Still, most studies had reported difficulties recognising a specific emotion, whilst the ability to identify other emotions remained unaltered (Castro, Davies, Hale, Surguladze, & Tchanturia, 2010; Kucharska-Pietura, Nikolaou, Masiak, & Treasure, 2004; Kuhnpast, Gramann, & Pollatos, 2012; Legenbauer, Vocks, & Ruddle, 2008; Lule et al., 2014; Pollatos, Herbert, Schandry, & Gramann, 2008). However, there was little consensus on which emotions were affected and which ones were not (with the exception of happiness, which recognition was usually unaltered). These previous studies had in common the use of photographs of faces of ‘actors’ portraying prototypical expressions of emotions, in which a single emotion is depicted very intensely. Instead, in reality facial expressions are usually ambiguous and often involve blended emotions (Buisine et al., 2006; Ekman & Cordaro,

2011). Therefore, studies 3.1 and 3.3 aimed to contribute to this literature by investigating emotion recognition using more ecologically valid stimuli, with pictures of blended facial expressions of emotions. The studies' findings indicated difficulties in disgust recognition, but no evidence of other problems in emotion recognition. Overall, these results are in agreement with the previous literature, showing difficulties in one discrete emotion, and unaffected ability to recognise positive emotions (i.e., happiness) in ED (Tchanturia, Dapelo, Harrison, & Hambrook, 2015).

The evidence of problems in disgust recognition is in accordance with results from previous studies of facial emotion recognition in AN (Lule et al., 2014; Pollatos et al., 2008), but is novel in BN. Previous studies in people with BN had reported difficulties in surprise (Kessler et al., 2006; Legenbauer et al., 2008) and anger (Kuhnpast et al., 2012), but not in disgust recognition. There is preliminary evidence that problems in emotion recognition constitute a trait associated with a lifetime history of AN (Harrison, Tchanturia, & Treasure, 2010). If this is the case, a possible explanation for the discrepancies between the results of study 3.2 and the previous literature in BN could be that around a half of the participants in the BN group had a past AN diagnosis.

Findings from study 3.1 and 3.3 also revealed a response bias towards anger, indicating that participants with ED showed a preference to label non-angry facial expressions as anger. This aspect of emotion recognition had received little attention in the ED field, with only two previous studies reporting information about it, both in AN participants (Castro et al., 2010; Jansch et al., 2009). None of these studies found a response bias towards a discrete emotion: Jansch et al. (2009) reported more misclassifications for all emotions in AN, and Castro et al. (2010) found no evidence of response bias.

The results on response bias found in study 3.1 and 3.3 could be related to attentional bias in ED. There is evidence of attentional bias towards angry and rejecting faces in people with

AN (Cardi, Di Matteo, Corfield, & Treasure, 2013; Harrison, Sullivan, Tchanturia, & Treasure, 2010), which could result in more attention to be paid to micro signs of anger, or to muscular actions that the anger response shares with the facial expression of disgust, such as brow lowering (Ekman & Friesen, 2003; Gery, Miljkovitch, Berthoz, & Soussignan, 2009). Thus, the person would misinterpret the whole facial expression as anger.

A secondary objective of study 3.1 and 3.3 was to explore the role of clinical characteristics (e.g., BMI, length of illness, medication status) and comorbidities (e.g., depression, anxiety) on poor facial emotion recognition. The results indicated that none of these clinical characteristics was associated with poor disgust recognition. These findings are not in line with previous evidence suggesting that these characteristics were linked to poor emotion recognition in people with ED (Castro et al., 2010; Jansch et al., 2009; Lule et al., 2014; Zonnevijlle-Bender et al., 2002).

Study 3.1 and 3.3 showed similar findings for participants with AN and BN. Even though the results indicate that people with AN have more difficulties recognising disgust, and show a higher response bias towards anger than BN (Figure 5.1); overall, the data suggest that there might be similarities in emotion recognition in both disorders. These findings, along with the evidence of high crossover between AN and BN diagnoses (Anderluh, Tchanturia, Rabe-Hesketh, Collier, & Treasure, 2009; Eddy et al., 2008), may support a transdiagnostic approach when investigating emotion recognition in ED.

**Figure 5.1. Percentage correct response and response bias for AN, BN and HC participants in emotion recognition from blended facial expression**

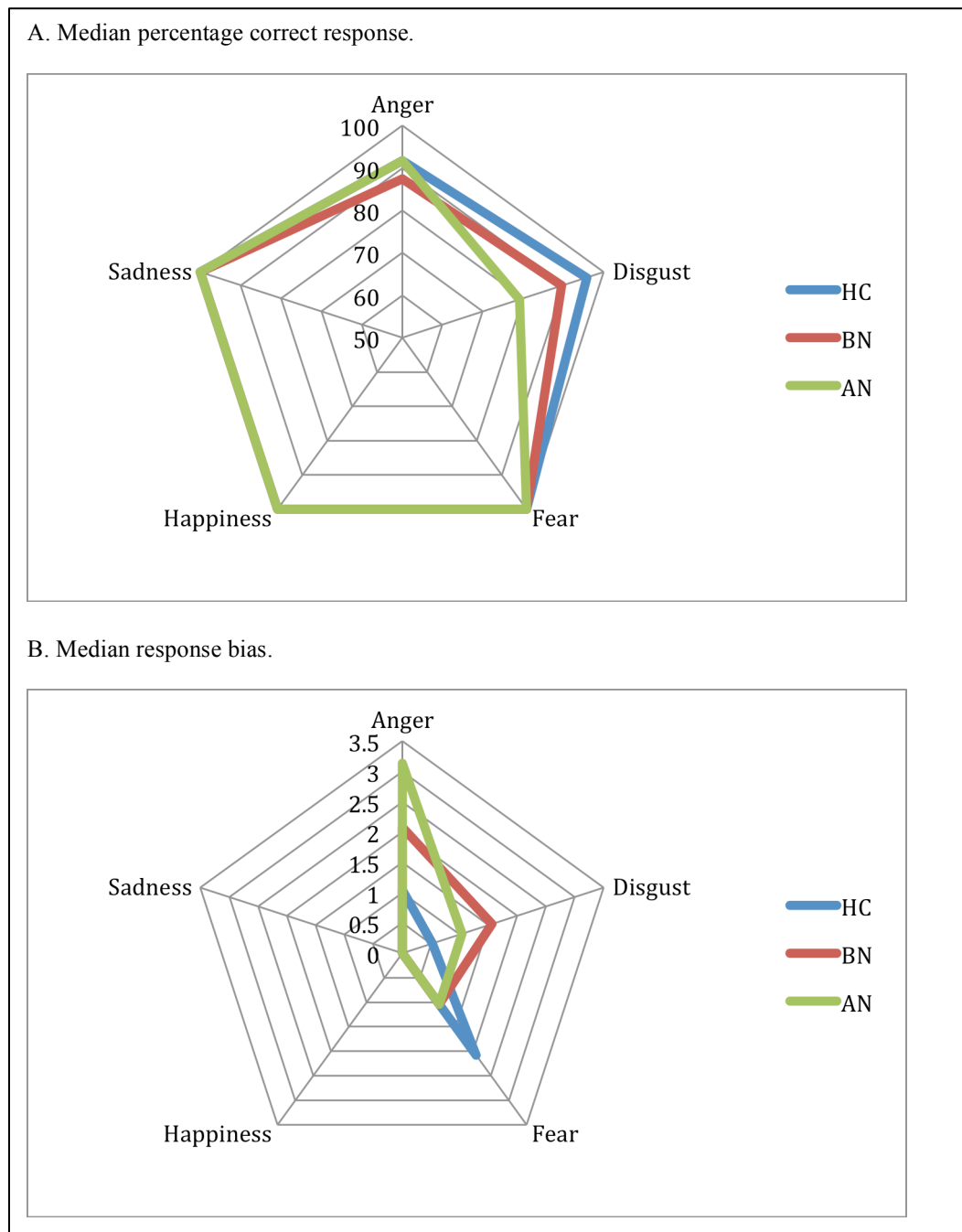


Figure 5.1. For visual clarity, radar charts used combine the results of study 3.1 and 3.3. Graph A shows median percentage correct response for AN, BN and HC groups on emotion recognition of less ambiguous facial expressions (90% blends). It can be seen that the AN group had a lower percentage correct response, followed by the BN group. No differences were found in the recognition of other emotions. Graph B shows median response bias for all groups. It can be seen that the AN group exhibit the highest bias towards anger, followed by BN. The BN group showed a trend for a disgust bias, but this was not significant.

#### *5.1.2.1. Emotion recognition from body movements (Aim 2)*

The aim 2 of this thesis was to evaluate emotion recognition from body movements in people with ED. Prior to this thesis, only one study had explored emotion recognition from body movements in ED, reporting difficulties in sadness recognition in AN participants (Zucker et al., 2013). Results from study 3.2 indicated that participants with AN had difficulties recognising sadness from body movements, compared to HC. Further analysis showed that adolescent AN participants had more difficulties than adults with AN and HC.

The results of study 3.2 provide evidence of difficulties recognising sadness in body movements in AN. However, it needs to be noted that in study 3.2 the difference in sadness recognition between AN and HC participants was largely driven by age, with adolescent AN participants exhibiting the worse performance. Instead, the participants of Zucker et al. (2013) study were adults (mean age was 26 years). Therefore, even though the two studies obtained similar results, the findings of study 3.2 contribute to the literature suggesting that there may be developmental aspects implicated in the problems in sadness recognition exhibited by AN participants.

On the other hand, study 3.3 showed no evidence of difficulties in emotion recognition from body movements in BN. At first sight, the results of this study and study 3.2 may indicate that participants with AN differ from those with BN in body emotion recognition. However, when only adult participants with AN are considered, both groups exhibit similar performance (i.e. median sadness recognition for adults with AN in study 3.2 was the same of BN participants in study 3.3), providing further evidence of similarities in emotion recognition in AN and BN.

The results from the studies of emotion recognition from facial expressions showed difficulties in disgust recognition and a response bias towards anger, whilst those from the



studies of emotion recognition from body movements found no evidence of difficulties in the adult participants. The difference in results may be explained because some emotions are more reliably recognised in the face than the body, or vice versa (Keltner & Lerner, 2010). Moreover, participants with ED only had difficulties recognising disgust in faces, and disgust was not assessed in the body motion task, which limits the interpretation. Future studies need to explore this in more detail.

## **5. 2. EMOTION EXPRESSION**

### **5.2.1. Summary of study findings**

#### *5.2.1.1. Study 4.1: Facial expression of positive emotions in individuals with ED*

The study investigated positive facial expression in people with ED through an examination of the Duchenne smile (DS) expressed in response to a humorous film clip.

Results indicated that participants with AN displayed DS for shorter duration than BN and HC participants, and their DS had lower intensity. A secondary objective was to explore associations within the clinical group between clinical variables (i.e., BMI, length of illness, medication, ED symptoms, anxiety, depression, and alexithymia) and the display of DS. Results showed that DS duration and intensity were significantly associated with BMI. In addition, clinical participants who were taking psychotropic medications at the time of the study had less DS duration and intensity.

This study also assessed the display of Non-Duchenne smiles (NDS), which even though not linked to positive affect, may have a relevant role in social interaction. Results indicated that participants with AN and BN exhibited NDS for less duration than HC, and the intensity of NDS was lower in AN participants, compared to the BN and HC groups. Clinical participants

with higher levels of alexithymia showed lower NDS duration. No other associations were found.

The study provides further evidence for a reduced facial expression of positive emotions in people with AN.

#### *5.2.1.2. Study 4.2: Facial expression of negative emotions in individuals with ED*

The study investigated facial expression of negative emotions in people with AN and BN compared to HC, by looking at expressions of sadness and other negative emotions in response to a sad film clip.

The results revealed that a considerable number of participants did not exhibit facial expressions of these emotions whilst watching the film clip (ranging from 30% in the HC group to 45% in the ED groups). Moreover, there were no statistically significant differences among the groups, showing no evidence of reduced facial expression of negative emotions in people with AN and BN, when compared to HC.

#### *5.2.1.3. Study 4.3: Deliberately generated and imitated facial expression of emotions in people with ED*

The study explored the ability to pose and imitate facial expressions of emotions in ED.

The results for posed emotion accuracy revealed that both AN and BN participants were significantly less accurate posing facial expressions of emotions than the HC group, with results remaining significant after controlling for comorbidities (i.e., anxiety, depression, and autistic traits). There were no statistically significant associations between posed emotion accuracy and clinical characteristics, such as BMI, length of illness, medication, and ED features.

Results from imitation accuracy indicated that participants with AN were less accurate than HC at imitating facial expressions of emotions. Participants with BN did not differ from AN or HC participants, having middle scores in the imitation task. The results remained significant after controlling for the effect of comorbidities. BMI was positively associated with imitation accuracy.

This is the first study to investigate the ability to pose and imitate facial expressions of emotions in people with ED. The study results add to the literature on emotion expression, further supporting the findings of reduced expressivity in AN.

### **5.2.2. Synthesis with existing literature**

#### *5.2.2.1. Spontaneous facial expression of emotions (Aim 3)*

Aim 3 of this thesis was to assess spontaneous facial expression of emotions in people with ED. Previous studies using the same experimental paradigm had consistently reported a reduced facial expression of positive and negative emotions in AN (Davies, Schmidt, Stahl, & Tchanturia, 2011; Rhind, Mandy, Treasure, & Tchanturia, 2014). In contrast, previous findings for BN were less coherent, with one study finding no differences in the expression of joy and anger of BN and HC participants (Claes et al., 2012), and another study finding reduced expression of anger, but heightened expression of joy in BN participants (Tarrega et al., 2014).

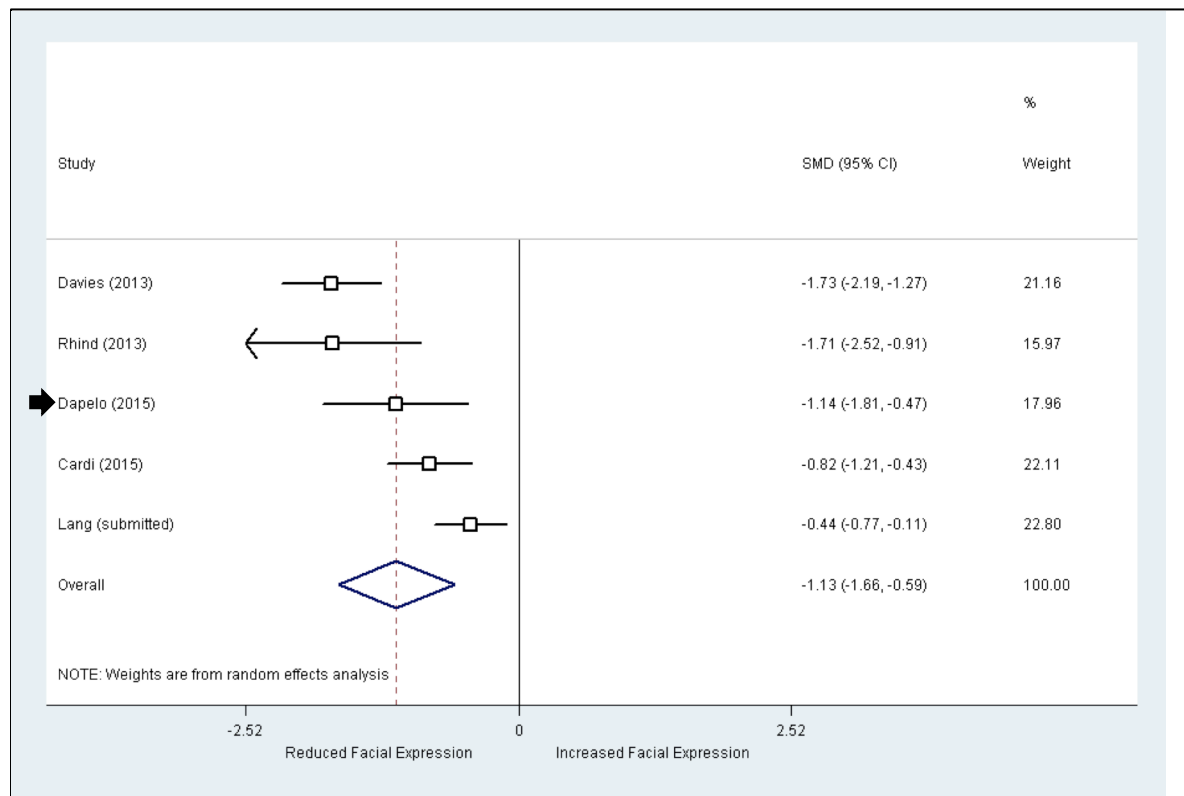
At the present, most of the studies on AN participants had used a coding system that classifies facial expressions according to a dimensional view (positive or negative emotions) (FACES; Kring & Sloan, 1991). By looking at the overall facial expression, this system does not inform about the specific emotion being displayed. In addition, even though the coding system has guidelines to inform which expressions are considered ‘positive’ or ‘negative’, it

relies on the subjective interpretation of the coder, rather than objective signs. Studies 4.1 and 4.2 were designed to build upon these studies, using a very similar stimuli and experimental procedures, but a different coding system. The FACS (Ekman, Friesen, & Hager, 2002) coding system used in the present studies relies on the objective assessment of facial action, and thus it is less subject to the coder's interpretation, and provides information about facial expressions that are specific to basic emotions.

The findings from study 4.1 showed reduced Duchenne smiling (DS) in AN participants. As it can be seen in the forest plot displayed in figure 5.2, the results of this study are consistent with the previous literature (Davies et al., 2011; Rhind et al., 2014), and with the findings of more recent studies (Cardi, Corfield, et al., 2015; Lang et al., 2016). The study is relevant because it is the only one to distinguish facial expressions that are linked to genuine positive affect (i.e. DS) from those that are expressed because of social convention (i.e. NDS), confirming previous findings using a different, more detail-oriented facial expression coding system.

Previous studies on people with BN had used a different paradigm, assessing facial expression whilst participants were playing a therapeutic video game (Claes et al., 2012; Tarrega et al., 2014). One limitation of this design is that the mood elicitation is not equal for all participants. The interactive nature of the videogame is likely to evoke positive and negative feelings depending on how well the participant is playing, with likely differential reward contingencies. Thus, there is poor control in the extent to which each participant would be cued to feel positive or negative feelings. Study 4.1 overcomes that limitation by using the same stimulus to elicit positive emotions for all participants. Its results for DS are consistent with findings from Claes et al. (2012), finding no differences in duration and intensity of DS between BN and HC groups.

**Figure 5.2. Forest plot of findings of studies investigating spontaneous facial expression of positive emotions in people with AN**



The arrow indicates the results of study 4.1.

The results of study 4.2 did not find significant differences in spontaneous facial expression of sadness, anger or disgust among participants with AN, BN and HC. These findings are not congruent with previous research, which has shown reduced expression of negative emotions (Cardi, Corfield, et al., 2015; Claes et al., 2012; Davies et al., 2011; Rhind et al., 2014). The differences in finding could be explained in part by differences in methodology. Even though the study design of study 4.2 was almost exactly the same of Davies et al. (2011) and Rhind et al. (2014), as mentioned before those studies used a coding system that focuses on the overall facial expression (FACES; Kring & Sloan, 1991), whereas study 4.2 used a more detail-oriented coding system to assess all facial movement (FACS; Ekman et al., 2002) and then selected only the facial movements that have been linked to specific discrete emotions (sadness, anger, disgust, and fear) for analysis. Even though FACS is considered the gold standard methodology for coding facial expressions (Sayette, Cohn, Wertz, Perrott, & Parrott, 2001), selecting only the facial expressions that have been linked to specific emotions may have reduced the number of expressions analysed, missing facial expressivity that could have been considered using FACES. Another explanation for the null findings relates to the emotion elicitation used in the study. The self-report of emotional experience before and after watching the film clip indicated that the film clip used was able to produce a statistically significant increase in negative emotions; however, the magnitude of the increase was very small. This may suggest that the film clip did not produce a strong emotion elicitation in the study participants. A mild emotion may not produce a facial response (Ekman & Friesen, 2003), which would explain the finding that around a half of the participants did not show facial expressions of negative emotions whilst watching the film clip. Using a different film clip (e.g., the clip used by Wildes, Marcus, Bright, & Dapelo, 2012) or a different procedure to induce negative emotions (e.g., the procedure used by Fox et al., 2013, in which participants watched an anger-inducing film clip, and then were

instructed to recall and write down a recent event that had made them feel angry) could have lead to more intense negative emotions, allowing for more conclusive results. Given these limitations, we think that the reduced facial expression of negative emotions previously reported for ED participants might be sensitive to study measurement. More research is needed to clarify which coding systems are more sensitive to minor differences in facial expression. New developments of computer software technology aimed at coding facial expressions automatically (e.g., Girard, Cohn, Jeni, Sayette, & De la Torre, 2014) may be of help in clarifying the incongruent findings of this study.

**Figure 5.3. Duration and intensity of spontaneous facial expressions of emotions in AN, BN and HC**

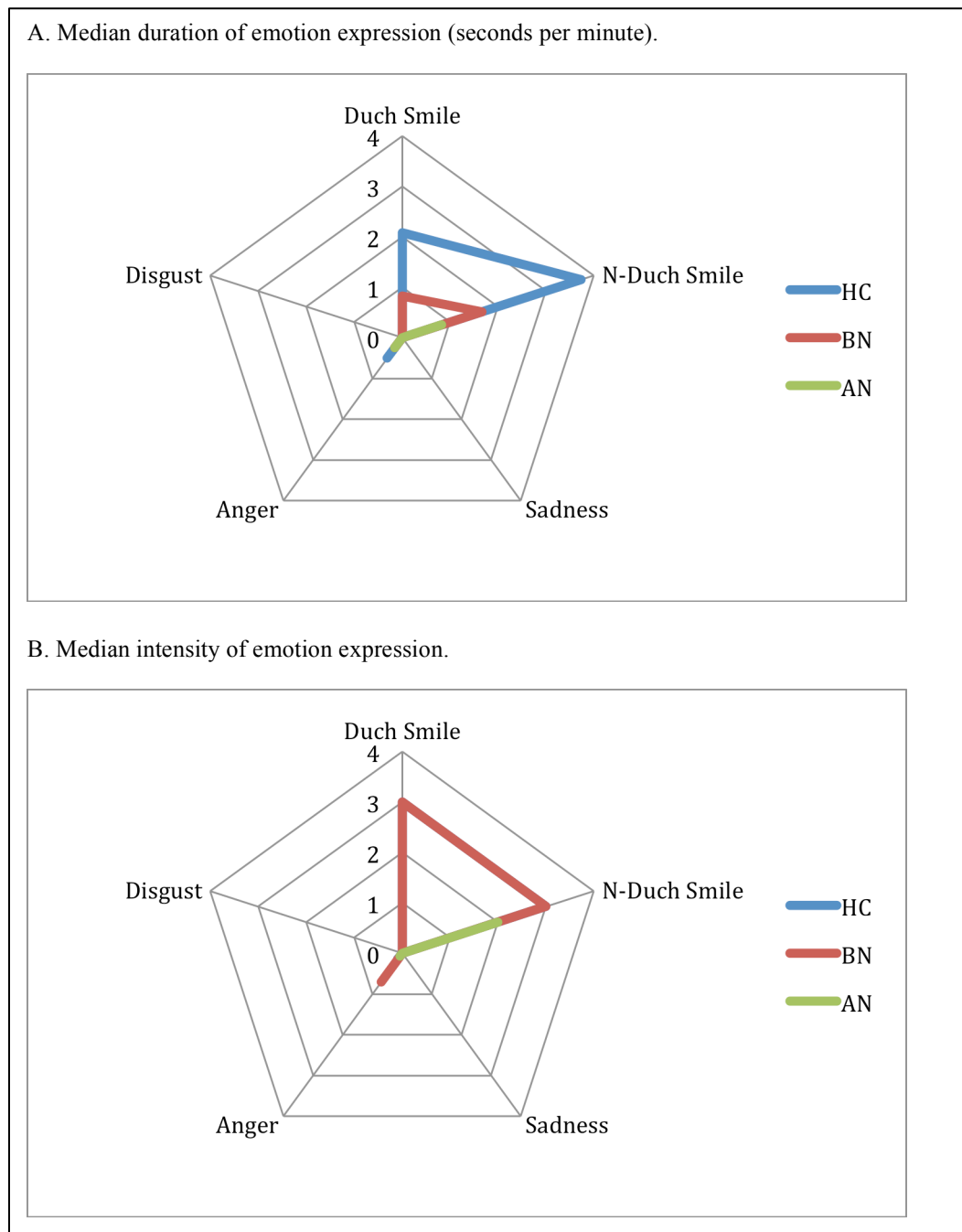


Figure 5.1 combines the results of study 4.1 and 4.3. Graph A shows median duration of spontaneous facial expressions for happiness (distinguishing Duchenne smile (DS) and Non-Duchenne smile (NDS)), sadness, anger and disgust for AN, BN and HC groups. It can be seen that the AN group showed DS and NDS for the shortest duration. Whilst BN participants showed DS and NDS for slightly shorter numerical duration than HC, the difference was only statistically significant in the case of NDS. Graph B shows median intensity of spontaneous facial expressions for all groups. It can be seen that both DS and NDS in the AN group were less intense than BN and HC, which generally did not differ. Intensity for BN and HC groups were the same for all emotions but anger (BN=0.71; HC=0.14), but the blue line showing results for HC is not visible in the chart.



#### *5.2.2.2. Posed facial expression of emotions (Aim 4)*

Aim 4 of this thesis was to explore posed facial expression of emotions in people with ED. This is a novel area that has not been investigated in the ED field, but prior to the study there has been research concerning difficulties posing facial expressions of emotions in children and adults with ASD (Faso, Sasson, & Pinkham, 2015; Loveland et al., 1994; Macdonald et al., 1989). There is evidence that some patients with AN share certain socio-emotional difficulties with ASD (Huke, Turk, Saeidi, Kent, & Morgan, 2013; Mandy & Tchanturia, 2015; Tchanturia, Smith, et al., 2013), such as social anhedonia (Chevallier, Grezes, Molesworth, Berthoz, & Happe, 2012; Harrison, Mountford, & Tchanturia, 2014; Tchanturia et al., 2012), problems in emotional intelligence (Hambrook, Brown, & Tchanturia, 2012; Petrides, Hudry, Michalaria, Swami, & Sevdalis, 2011), and difficulties in theory of mind (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Oldershaw et al., 2011; Tchanturia et al., 2015); and approximately 23% of adults with AN might also meet full diagnostic criteria for ASD (Gillberg, 1983; Huke et al., 2013). Thus, studying the ability to pose emotions in AN could inform the literature regarding overlapping features of AN and ASD.

The results from study 4.3 indicated that ED participants had difficulties posing facial expressions of emotions, when compared to HC; which would be consistent with the literature on ASD, suggesting that autistic traits in ED could be a factor. However, the results remained significant after controlling for autistic traits, suggesting that the difficulties are at least in some degree, specific to the ED.

The results from study 4.3 could be related to the findings on Non-Duchenne smile (NDS) from study 4.1. NDS are thought to be intentional (Ekman, Davidson, & Friesen, 1990), and can be displayed in response to social demands (Hess & Bourgeois, 2010). Posed expressions, on the other hand, are intentional and can be used to deliver a social message (Dethier, Blairy, Rosenberg, & McDonald, 2012). Therefore, NDS could be conceptualised

as posed smiles. It is interesting to note that in both cases (NDS and posed emotions), participants with BN showed differences in comparison to HC. BN participants exhibited NDS for less duration, and were less accurate posing facial expressions of emotions than HC. These difficulties found in non-spontaneous facial expression in studies 4.1 and 4.3 may warrant further exploration in this group.

#### *5.2.2.3. Imitation of facial expressions of emotion in people with ED (Aim 5)*

Aim 5 of this thesis was to explore imitation of facial expression of emotions in people with ED. This is another area that has not been studied in ED, but difficulties in imitation of facial expressions are commonly reported in the ASD literature (for a review, see Seveler & Gillis, 2010). The findings from study 4.3 indicated that participants with AN had difficulties imitating facial expressions of emotions, supporting the evidence of similarities between AN and ASD. It must be noted, nevertheless, that these results remained significant after controlling for the effect of autistic traits, suggesting that these difficulties are not completely explained by some shared autistic traits.

It has been proposed that imitation is a key mechanism in the development of facial expressions of emotions (Whiten et al., 1999; Williams, Nicolson, Clephan, de Grauw, & Perrett, 2013). In this context, the results from study 4.3 are consistent with the literature on spontaneous facial expression in ED, showing difficulties imitating facial expressions of emotions in AN, but not in BN. Furthermore, results from study 4.1 and 4.3 indicated that BMI was positively associated with both, spontaneous expression of positive emotions (i.e. DS) and imitation accuracy. These findings provide preliminary support for the idea that imitation might be linked to spontaneous expression of emotions in ED, and warrants further study exploring the impact of imitation in facial expressivity in ED, as well as the role of

BMI. For example, through the use of cross-sectional studies including weight-restored AN participants.

### **5.3. IMPLICATIONS FOR EMOTIONAL MAINTENANCE MODELS OF ED**

The findings on emotion recognition have implications for some of the maintenance models of ED described in chapter 1. Studies on facial emotion recognition (study 3.1 and 3.2) showed that participants with ED tended to misclassify facial expressions of disgust, misinterpreting them as angry. Furthermore, they showed a preference to label facial expressions as angry, even if there was little to no sign of anger being portrayed. These results suggest problems in the processing of these two basic emotions in people with ED. This may provide support for the SPAARS model of ED (Fox, 2009), in which anger and disgust are seen as particularly salient emotions. The model poses that anger is perceived as particularly threatening for people with ED, and thus it may have become coupled with disgust through the course of development. Because of this association between both emotions, every time anger is experienced by someone with ED, it is inhibited and replaced by disgust towards oneself (Fox & Froom, 2009). Disgust is an emotion closely related to rejection (Ekman & Friesen, 2003). Thus, it could be speculated that if anger, disgust, and rejection are usually linked to each other, the differences amongst them may be blurred for people with ED. In consequence, a face portraying disgust could be experienced by people with ED as rejecting, and interpreted as anger.

The Mentalising model of AN poses that problems in mentalising are central to AN, and it predicts that these problems translate into difficulties interpreting ones and other people's emotions, amongst other difficulties (Skarderud, 2007). The misinterpretation of disgust as

anger showed by AN participants in study 3.1 is consistent with this model, and may be indicative of more general problems in the ability to represent mental states.

Finally, the findings of poor disgust recognition may be of particular importance for people with AN. The emaciated body of AN patients could evoke feelings of disgust in others. In addition, people with AN are particularly self-conscious, and tend to experience high levels of external shame, thinking that others are looking down on them (Gilbert, 1998). In this context, difficulties recognising disgust could protect the self from further feelings of rejection. However, the misinterpretation of disgusted faces as being angry suggests the opposite, indicating that people with AN may experience disgusted facial expressions as actively rejecting, promoting further feelings of shame and isolation.

Most of the emotional maintenance models of ED described in chapter 1 highlight the relevance of emotion avoidance in the maintenance of AN (Lynch, Hempel, & Dunkley, 2015; Schmidt & Treasure, 2006; Wildes & Marcus, 2011). Given that emotion avoidance involves the desire to avoid expressing emotions (Wildes & Marcus, 2011), the reduced expression of emotions, either spontaneous or posed, showed by AN participants in studies 4.1 and 4.3 may provide experimental support for these models. Moreover, the findings of reduced expression of positive emotions (study 4.1) expand the models' view that people with AN avoid the expression of negative emotions, evidencing that they also avoid the expression of positive emotions.

The results from study 4.1 provide particular support for the Radically open-dialectical behaviour therapy model of AN (Lynch et al., 2015). This model poses that AN is a disorder characterised by overcontrol, in which a temperamental threat sensitivity tends to bias the

person to notice the potential for harm when interacting with others, making it less likely for them to respond with genuine enjoyment or pleasure (Lynch et al., 2013). Therefore, this model directly predicts that people with AN will not exhibit Duchenne smiles (DS) when interacting with others. Even though the experimental task used in study 4.1 is not necessarily social in nature, this model provides a plausible explanation for the reduced duration and intensity of DS in participants with AN, compared to BN because the latter is characterised by impulsivity, rather than overcontrol.

The Emotion acceptance behaviour therapy model of AN (EABT; Wildes & Marcus, 2011) emphasises the role of comorbidities, specifically depression and anxiety, linking them to emotion avoidance. However, the results in emotion expression showed no association with levels of comorbid depression or anxiety. Therefore, the findings in emotion expression do not support the key role that EABT poses on comorbidities in the development of emotion avoidance in AN.

The difficulties in emotion recognition and expression found in this thesis could be signs of more generalised problems in the development of attachment relationships, mentalising abilities, and the self in people with ED. The results of imitation are particularly congruent with the disturbances in the mother-child relationship described for people with AN by Selvini (1978) and Bruch (1982). The developing of facial imitation starts early on in infancy, when the caregiver and child mirror each other's facial expression, which allows the child to imitate the caregiver and learn to convey messages through the face (Meltzoff & Moore, 1977). The difficulties exhibited by people with AN in study 4.3 could relate to a lack of regular response from the caregiver to the child's facial expression, which has been proposed to play a key role in the development of AN (Bruch, 1982). Furthermore, this

reduced feedback given by the caregiver could also be linked to the general lack of facial expression found in people with AN in this thesis (study 4.1) and the literature.

In his attachment theory, Bowlby (1979) suggested that infants develop mental representations of the self and others in response to their repeated experiences of the availability and responsiveness of their caregiver (Bowlby, 1979). According to Fonagy (2006) individuals who are neglected in early relationships where their emotional experience is not adequately mirrored by the caregiver, develop a fragile capacity to represent mental states and affect. In this context, if the reduced facial expressivity found in this thesis is linked to problems in early relationships with the caregiver, it could also be linked to the evidence of insecure attachment and problems in mentalising abilities found in AN (Skarderud, 2007; Jewell et al., 2015). Future studies could test the link between reduced emotion expressivity, attachment, and mentalising abilities in people with AN.

#### **5.4. IMPLICATIONS FOR SOCIAL FUNCTIONING**

People with ED, specially AN, have difficulties in social functioning (Harrison et al., 2014; Tchanturia, Hambrook, et al., 2013), establishing friendships (Doris, Westwood, Mandy, & Tchanturia, 2014), and struggle with loneliness and isolation (Treasure, Crane, McKnight, Buchanan, & Wolfe, 2011). The difficulties in emotion recognition and expression evidenced by the studies carried out in this thesis are likely to contribute to this pattern.

The preference to interpret non-angry expressions as anger evidenced in studies 3.1 and 3.2 may have relevant social consequences. According to Fridlund (1994) anger's social function is to communicate an attack message, which is very likely to influence the behaviour of the receiver promoting either to escape or to fight back. Considering the evidence that people

with AN experience anger as threatening and inhibit its response (e.g., Espeset, Gulliksen, Nordbo, Skarderud, & Holte, 2012; Fox, 2009; Ioannou & Fox, 2009), it is likely that the misinterpretation of inoffensive messages as an attack will lead to an escape reaction, which may translate into social withdrawal.

The reduced emotion expression found in participants with AN is also likely to impact social functioning. The first axiom of communication states that ‘one cannot not communicate’, thus, even the absence of action, has the potential to be interpreted by others as having some meaning (Watzlawick, Beavin-Bavelas, & Jackson, 1967). In fact, it has been shown that people perceive someone with reduced expression of emotions as untrustworthy or inauthentic (English & John, 2013), reserved and unhappy (Bogart, Tickle-Degnen, & Ambady, 2014; Tickle-Degnen & Lyons, 2004) and report being less interested in establishing friendship ties with the inexpressive person (Hemmesch, Tickle-Degnen, & Zebrowitz, 2009). Thus, the reduced expression exhibited by people with AN in study 4.1 and 4.3 may clearly hinder their ability to connect and form friendships with others.

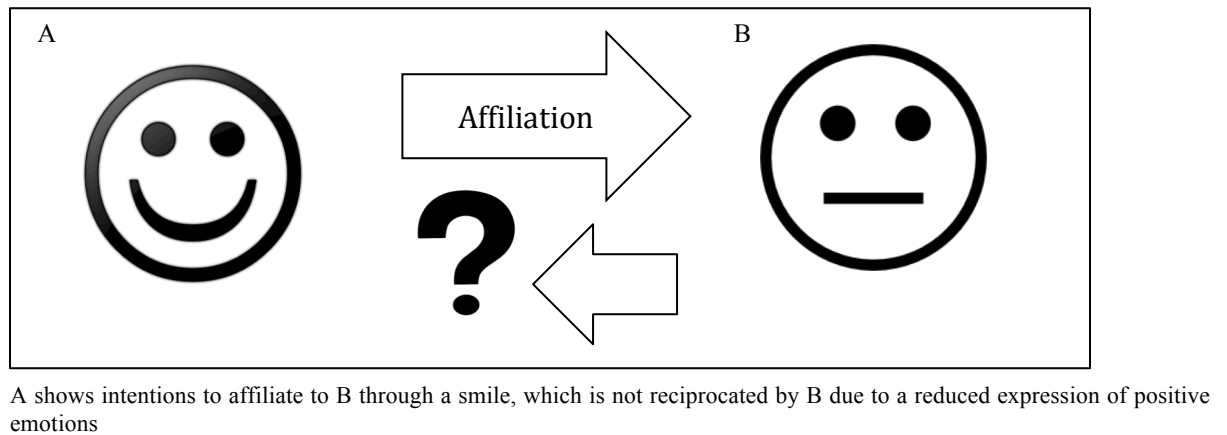
Even though most of the evidence of reduced facial expression was found for the AN group, the BN participants showed reduced Non-Duchenne smile (NDS) and were less accurate posing facial expressions of emotions. Posed facial expressions, being deliberate in nature (Rinn, 1984), have been linked to the intentional use of facial expression to communicate social messages or intentions (Dethier et al., 2012). Therefore, the findings of studies 4.1 and 4.3 may suggest that people with BN also have difficulties conveying emotional messages to others, which could affect social functioning (Heyes, 2009).

Emotion recognition and emotion expression are distinct processes, however, they are constantly influencing each other on every day social interactions. Therefore, the problems evidenced by the studies involved in this thesis could add up, worsening social functioning. It has been proposed that negative biases in the perception of emotions in others may lead to an inappropriate behavioural response, which if being reciprocated, can sustain a vicious cycle that is difficult to stop (Penton-Voak, Bate, Lewis, & Munafo, 2012). The vignettes shown in figure 5.4 could illustrate this vicious cycle with an example. In the first vignette, one person (A) approaches someone with AN (B) with friendly intentions, showing a Non-Duchenne smile as a sign of affiliation. This smile is not reciprocated by B, given the reduced facial expression of positive emotions exhibited by AN, sending no clear message back to A. As it is shown in the second vignette, B's response may leave A wondering what to do; A may still feel enthusiastic about being friends with B, but also feel slightly frustrated because of the interpretation that B is disregarding her intentions. This mix of emotions may show in A's face as a blend of happiness (emotion family that includes enthusiasm) and anger (emotion family that includes frustration). The bias towards anger shown by AN participants in this thesis may suggest that B would immediately interpret A's expression as anger/rejection. This is likely to lead to an end of the interaction, missing the opportunity of a rewarding experience/relationship. In addition, it may elicit in B negative emotions, such as sadness or fear. Theoretically, these negative emotions may lead to ED symptoms that function to regulate the negative emotions (Fox & Froom, 2009; Lynch et al., 2013; Schmidt & Treasure, 2006; Wildes & Marcus, 2011). This example illustrates how the bias towards anger and the reduced expression of positive emotions found in this thesis can interact in a vicious cycle, increasing negative affect, and potentially leading to social isolation and ED behaviours.

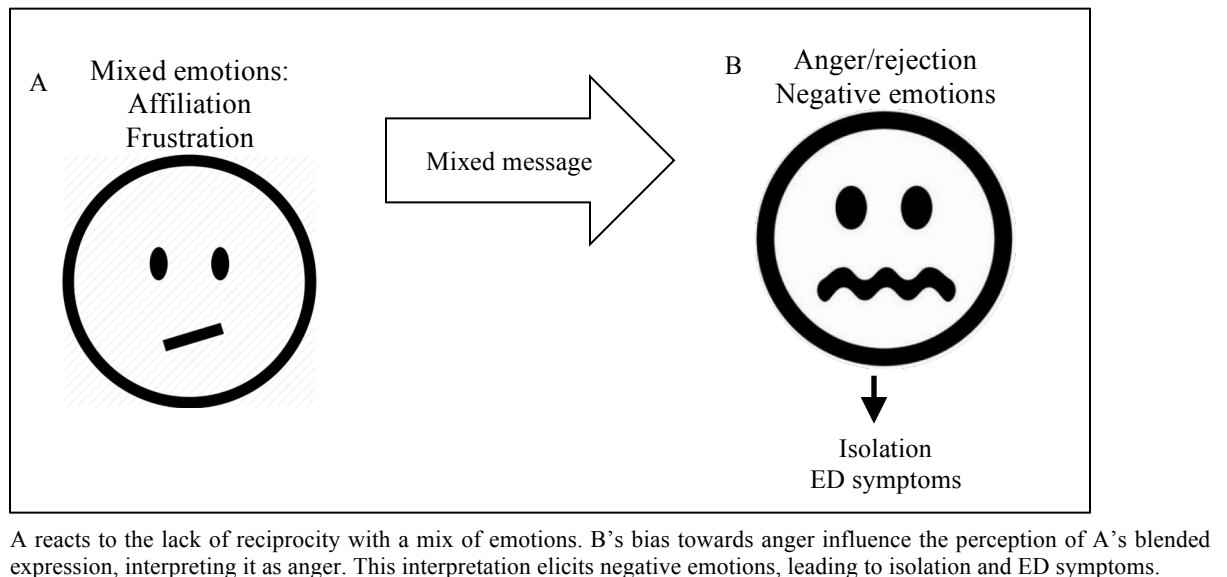


**Figure 5.4. Illustration of the effect of bias towards anger and reduced facial expression in an every-day social interaction**

Vignette 1.



Vignette 2.



## **5.5. IMPLICATIONS FOR ED TREATMENT**

The findings of the studies carried out in this thesis have the potential to be translated into clinical practice by defining treatment targets, informing existing treatments with an emphasis on emotional functioning, such as the Maudsley model of treatment for adults with AN (MANTRA; Schmidt et al., 2013), Cognitive remediation and emotion skills training (CREST; Money, Genders, Treasure, Schmidt, & Tchanturia, 2011), Emotion acceptance behaviour therapy (EABT; Wildes & Marcus, 2011), Mentalisation-based therapy for eating disorders (MBT-ED; Robinson et al., 2014; Skarderud, 2007c), Radically open-dialectical behaviour therapy for anorexia nervosa (RO-DBT; Lynch et al., 2013), and Compassion-focused therapy for ED (CFT-E; Goss & Allan, 2010, 2014).

Findings on emotion recognition suggest that it might be relevant to target the tendency to interpret non-angry expressions as anger shown by ED participants. Interventions targeting negative interpretation bias have shown to be effective in people with depressive symptomatology (Penton-Voak et al., 2012), and may be of value for people with ED. There is preliminary evidence of the effectiveness of cognitive bias modification intervention at reducing negative attentional and interpretation biases in people with AN (Cardi, Esposito, et al., 2015). The findings of this thesis underscore the need to further investigate this type of interventions, to evaluate its addition to more established treatments with emphasis on everyday interaction skills, such as CREST.

In addition, the bias towards anger found in people with ED highlight the relevance of therapeutic approaches aimed at reducing self-criticism, self-directed hostility and shame, such as Compassion-focused therapy for ED (CFT-E; Goss & Allan, 2010). A more

compassionate state of mind that can encourage genuine care for the self and others might promote a less negative interpretation of people's rejecting and neutral faces, enhancing emotion recognition.

Even though the above sections have discussed the problems participants with ED exhibited when recognising emotions on facial expression and body movements, it needs to be noted that for most emotions the performance of ED participants in emotion recognition tasks was very similar to HC. In this context, the results indicate that beside the specific difficulties in disgust and anger highlighted above, adults with ED do not exhibit major problems recognising basic emotions in facial expressions and body movements. This may suggest that emotion recognition could be considered strength, compared to other aspects of socio-emotional functioning in ED (e.g., emotion expression). Considering emotion recognition (particularly in the case of positive emotions) a strength has clinical implications, because there is a need for treatments to broaden their aims, considering both the improvement of deficits and the exploration of people's strengths (Fredrickson, 1998; Santos et al., 2013) as there is evidence that cultivating strengths can improve wellbeing (Lyubomirsky & Layous, 2013). Thus, emotion recognition of emotions such as happiness (which is largely conserved in people with ED) could be seen as an aspect to potentiate during treatment.

The difficulties in expression of positive emotions reported, as well as posing and imitating facial expressions of emotions, highlight the need for targeting emotion expression during the treatment of AN. Thus, these findings serve as supporting evidence for treatments such as CREST and RO-DBT, which include interventions aimed at heightening emotion expression. In addition, the results on Non-Duchenne smile and posed emotions may suggest that some focus on facial expression as a means to convey social messages and intentions may be also

of help in the case of patients with BN. In terms of specific strategies to translate the research results to treatment protocols, the findings can be included in psychoeducational materials. Further work will be needed to develop and tailor practical exercises aimed at increasing expressivity in ED patients.

Finally, as mentioned before, the difficulties in emotion recognition and expression found in this thesis may be linked to more global difficulties in the capacity to represent the self. Being able to recognise and express emotions requires mentalising abilities (Soderstrom & Skarderud, 2009), therefore treatments that encourage reflection over one's emotions and those of others in the context of a secure attachment, such as mentalising-based therapy for ED (MBT-ED; Robinson, 2014) could potentially have a positive impact on emotion processing.

## **5.6. STRENGTHS**

In general, the studies included in this thesis investigate novel areas, or build upon previous findings addressing some limitations in the literature. Moreover, the studies' findings provide support for emotional maintenance models of ED and inform clinical practice.

Specifically, studies 3.1 and 3.3 build upon previous literature on emotion recognition in ED using a novel set of stimuli, which is thought to be more ecologically valid than those used in previous studies.

Studies 3.2 and 3.3 investigate emotion recognition from body movements, an area that has received little attention in the ED field. Study 3.3 is the first to explore this ability in people with BN. In addition, study 3.2 benefits from a large sample size, including adolescents and adult participants.

Study 4.1 contributes to the literature on facial emotion expression in ED, confirming previous findings using a detail-oriented facial expression coding system that is considered the gold standard for measuring facial expression (Sayette et al., 2001).

Finally, study 4.3 is the first to explore the ability to pose and imitate facial expressions of emotions in people with ED, introducing a potential new area of study in the field.

## **5.7. LIMITATIONS**

Here are highlighted some of the limitations of this thesis' studies, which could be improved in future research.

### **5.7.1. Measures**

#### *5.7.1.1. Clinical Interview (SCID):*

The SCID (First, Gibbon, Spitzer, & Williams, 2002) is a well-validated clinical interview; however, it was designed for the assessment of DSM-IV criteria (APA, 2000) and it was used in this thesis to assess DSM-5 criteria for ED (APA, 2013). Given that this thesis started before the publishing of DSM-5, there were no tools designed for the assessment of DSM-5 criteria. Thus, the SCID was slightly modified to account for the main changes in diagnosis.

#### *5.7.1.2. Self report measures*

The self-report measures included in this thesis were established measures with known validity and reliability. However, there were a few cases in which the internal consistency of the measure in the study sample was not satisfactory (HADS-D for study 3.1, AQ-10 for study 3.2, HADS-D for study 4.1, and AQ-10 for study 4.3), which may have affected the

validity of the results. In addition, there are limitations inherent to self-report measures that must be acknowledged, particularly in terms of the possibility of bias in responses.

#### *5.7.1.3. Experimental tasks:*

With the exception of study 4.3, all experimental tasks used in this thesis had been validated in previous studies. However, they were not exempt from limitations.

The data from emotion recognition studies (studies 3.1, 3.2 and 3.3) was negatively skewed, indicating a ceiling effect. This may suggest that the difficulty of the tasks utilised in these studies was low, which could have reduced the sensitivity to find subtle differences among the groups.

The experimental task used in the spontaneous emotion expression studies (studies 4.1 and 4.2) included film clips that had been previously used to elicit emotions in people with AN (Davies et al., 2011). Data indicated that the film clips were successful at producing an increase in emotions, however, in the case of study 4.2, the evidence suggests that the increase in negative emotions was small. As a consequence, only around a half of the participants exhibited facial expressions of negative emotions, which is likely to have affected the study results.

Finally, the tasks used in study 4.3 were designed based on a previous study on posed and imitation of facial expressions of emotions (Schwartz, Mastropalo, Rosse, Mathis, & Deutsch, 2006), but have not been used before in people with ED. Therefore, these tasks do not have an established validity, and the results of this study should be taken as exploratory.

### **5.7.2. Sample size/Power**

Since most of the studies conducted in this thesis used either a novel experimental task, or investigated a novel area in ED, sample size estimations were based on similar studies carried out in people with other psychopathology, such as ASD or schizophrenia.

In general, the studies showed adequate power to detect significant differences in the main analysis. The only exception might be study 3.2, in which there was a trend towards significance for a response bias towards disgust found in participants with BN. It is possible that with a larger sample size, the differences observed would have reached statistical significance.

Even though the studies were well powered for the analysis carried out, in most cases the sample size was too small to conduct secondary analyses, such as exploring differences depending on AN subtypes. Given that overcontrol is more typical in AN-restricting type (Lynch et al., 2015), this analysis could have been relevant.

Finally, since the sample size calculation on study 4.3 was conducted using an overall outcome score that combines the scores for specific emotions, it was not possible to evaluate differences in the ability to pose and imitate facial expressions of emotions depending on the emotion being posed/imitated.

### **5.7.3. Recruitment bias**

The participants of the studies included in this thesis were volunteers who self-selected for participating. Thus, it is possible that those agreeing to participate in the study differed in some way to those who chose not to. For example, clinical participants who were willing to participate might be more motivated and have less social anxiety than those who were not, which could have affected the results.

#### **5.7.4. Study design**

The studies presented in this thesis were of a cross-sectional design; therefore it is not possible to make inferences regarding the chronology of the emotion difficulties in relation to the onset of the ED. Some emotional models of ED imply that emotional difficulties, such as emotion avoidance are developed prior to the ED (Fox & Froom, 2009; Wildes & Marcus, 2011). However, the cross-sectional design of this thesis precludes from any conclusions in this regard.

#### **5.7.5. Coding of facial expressions**

Studies 4.1 and 4.2 assessed the facial expression of participants using FACS, which is an objective, well-validated coding system.

Instead, study 4.3 used a judge-based system that was based on a previous study (Schwartz et al., 2006), and showed satisfactory inter-coder reliability (above 0.80), but which has not been validated. The lack of validation limits the interpretation of the study results, because it does not inform about the clinical value of the differences found between ED participants and HC.

Another limitation in the coding of facial expressions relates to coders' blindness status. Studies 4.1, 4.2, and 4.3 were rated by independent coders who were blind to participants' diagnosis and study hypothesis. However, coders blindness was limited because some of the AN participants were visibly underweight and therefore their group allocation may have been revealed to the rater. It was estimated that this was the case for around 15% of the AN participants.



#### **5.7.6. Participant characteristics**

A large number of clinical participants were receiving treatment from specialist ED service. It is possible that some of the interventions received by these participants aimed at improving emotional functioning, such as CREST. Moreover, the percentage of participants with BN receiving treatment was smaller than those with AN, which could have affected the results.

#### **5.7.7. Inclusion and exclusion criteria**

It was decided to include only women in all the studies. The reason for excluding men was pragmatic; given the smaller proportion of men with ED there were concerns about the feasibility of recruiting enough male participants to obtain meaningful results. There is evidence of gender differences in emotion recognition (Hall & Matsumoto, 2004) and emotion expression (Hess & Bourgeois, 2010), thus this thesis findings cannot be generalised to men with ED.

Even though initially the inclusion criteria for the HC sample included a BMI within normal range, this criterion was modified to include HC participants with higher BMI (up to a BMI < 30) if there were no evidences of ED behaviours (e.g., binge eating). The decision was made to not hinder recruitment, and considering that around 33% of adult women in England are overweight (Health Survey for England, 2013). Less than 20% of the HC participants were overweight on each study. For all studies, preliminary analyses were conducted with and without the overweight group, and results did not differ.

## **5.8. FUTURE DIRECTIONS**

### **5.8.1. Replication of novel studies**

Study 4.3 explores the ability to pose and imitate facial expressions of emotions in people with ED, providing preliminary evidence for difficulties in this area. It would be desirable to replicate these findings using a larger sample size, with enough power to conduct separate analysis for each basic emotion.

### **5.8.2. Emotion recognition in self and others**

This thesis explored the ability to recognise emotions in others, but did not evaluate the ability to recognise emotions in self. Early on, Bruch noted that patients with AN had difficulties identifying inner states, such as emotions (Bruch, 1962), which is supported by the literature on alexithymia and ED (for a review, see Nowakowski, McFarlane, & Cassin, 2013). Moreover, the difficulties recognising emotions in others found in this thesis may be indicative of more general problems in the ability to represent mental states. Therefore the relationship between the ability to recognise emotions in self and others should be explored in the future.

### **5.8.3. Effects of difficulties in emotion recognition and expression, on social functioning and ED behaviours**

The bias towards anger and reduced facial expression of emotions evidenced in people with ED are thought to hinder social functioning, and to increase negative affect and ED behaviours. This hypothesis is based on studies carried out in people with other psychopathologies (e.g., Bogart et al., 2014; Hemmesch et al., 2009; Keltner & Kring, 1998; Penton-Voak et al., 2012), and in the emotional maintenance models of ED (e.g., Fox &

Froom, 2009; Lynch et al., 2013; Schmidt & Treasure, 2006; Wildes & Marcus, 2011), but it requires empirical testing in people with ED.

Previous studies in individuals with ED have found association between bias towards angry faces and difficulties in emotion regulation (Harrison, Sullivan, et al., 2010), as well as reduced emotion expression and drive for thinness, bulimia, and body dissatisfaction (Ioannou & Fox, 2009). These studies provide support for the above-mentioned hypothesis. However, they have relied on self-report, thus future studies could test the effects of difficulties in emotion recognition and expression on social functioning and ED behaviours using an experimental paradigm.

#### **5.8.4. Difficulties in emotion recognition and expression: state or trait?**

Some emotional maintenance models of ED imply that difficulties in emotion processing are result of traits, acting as risk factors that increase the vulnerability to develop an ED (e.g., Wildes & Marcus, 2011), whilst others emphasise their role as maintenance factors, linking them to the acute illness state of the ED (e.g., Schmidt & Treasure, 2006).

A risk factor is a variable that is present before the onset of the illness and predicts its onset, but may or may not remain after the illness has remitted. Instead, a maintenance factor predicts the persistence of the illness over time and may or may not be present before the onset of the illness, but should no longer be present when the illness has remitted (Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001; Oldershaw et al., 2012; Stice, 2002). Distinguishing risk factors from maintenance factors is relevant not only for theoretical reasons, but also clinical: whilst risk factors inform about targets for prevention interventions, maintenance factors are to be targeted in treatment (Stice, 2002).

There is evidence suggesting that emotion recognition difficulties and attentional bias towards anger are present in people who have recovered from an ED (Harrison, Tchanturia,

et al., 2010). In addition, similarities in facial expression of emotions have been found between people with AN and those who have recovered (Davies, Schmidt, & Tchanturia, 2013). This preliminary evidence supports the view that the problems in emotion recognition and expression found in this thesis are based on traits that are assumed to be present before the illness and may constitute a vulnerability factor for the development of an ED (Harrison, Tchanturia, et al., 2010). Future studies on recovered participants, as well as longitudinal studies following cohorts of patients, and cohorts of people at high risk for ED should further inform about the nature of the difficulties in emotion processing found in this thesis and their contribution to the onset and maintenance of ED.

#### **5.8.5. Emotion recognition and expression in social interaction**

Interpersonal interaction is the primary elicitor of emotions (Andersen & Guerrero, 1998), yet most of the literature on emotion recognition and expression, including this thesis, has used paradigms that incorporate little to no social interaction. Studying emotions within social interaction is challenging, because it is more difficult to control variables, such as the emotion elicitation. On the other hand, they provide more valid information about the participants' behaviour in real life.

One interesting experimental paradigm that has been used successfully in people with borderline personality disorder is Cyberball (for a review, see Lis & Bohus, 2013). Cyberball is a virtual ball-tossing game in which the participant plays with two virtual players, symbolised by cartoon characters, tossing a ball to one another. There is a social inclusion condition, in which the ball is tossed equally often to all players, and a social exclusion condition, in which the subject is excluded by the other players and rarely receives the ball. The emotional experience and facial expression can be assessed during the game (Williams & Jarvis, 2006). This is an example of an experimental paradigm that allows for more control

over variables (i.e., inclusion and exclusion condition), whilst maintaining a social interaction nature. Future studies could explore emotion expression in ED using paradigms like Cyberball.

#### **5.8.6. Role of shame**

Shame was not investigated in the current thesis, but it known to be a relevant emotion for understanding ED psychopathology (for a review, see Goss & Allan, 2009), therefore it would be interesting to explore it in future studies. Moreover, shame could be linked to some of this thesis results. Feelings of shame and embarrassment could have had an impact in the emotion expression tasks, reducing expressivity due to the fear of being judged. Future studies may look at the association of internal and external shame and emotion expression in ED.

#### **5.8.7. Emotion expression, attachment, and mentalising**

The reduced emotion expression and the problems imitating emotional facial expressions exhibited by participants with AN in this thesis might be related to early problems in the ability of the caregiver to mirror and respond contingently to the infant's facial expression (Meltzoff and Moore, 1977). Thus, it could be hypothesised that these difficulties in emotion expression could be linked to difficulties in attachment. Given the evidence of insecure attachment and poor mentalising abilities found in AN (Skarderud, 2007; Jewell et al., 2015), it would be interesting if future studies could test the link between reduced emotion expressivity, attachment, and mentalising abilities in people with AN.

#### **5.8.8. Imitation as an intervention aimed at improving expressivity**

It has been suggested that imitation plays a role in developing control over facial expressions (Williams et al., 2013). Therefore, improving the ability to imitate facial expressions of emotions could enhance the ability to intentionally increase facial expressivity. There is preliminary evidence indicating that practicing imitation of facial expressions of emotions improves the ability to pose emotions in people with schizophrenia (Schwartz et al., 2006). Therefore, it is possible that through imitation exercises, people with ED could improve their ability to convey emotions and/or intentions. Future studies could explore this idea.

### **5.9. OVERALL CONCLUSION**

This thesis aimed to investigate emotion recognition and expression in individuals with ED, compared to HC. The thesis findings provide evidence of difficulties in this area. Specifically, people with ED had difficulties recognising disgust and a preference to misinterpret non-angry faces as anger. In addition, people with AN showed reduced spontaneous facial expression of positive emotions, and difficulties posing and imitating facial expressions of emotions. Participants with BN exhibited reduced posed expression of emotions. These difficulties may contribute to the maintenance of the ED and to problems in social functioning.

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## **APPENDICES**

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### **APPENDIX A. ETHICAL APPROVAL CONFIRMATION LETTER**

**NRES Committee London - West London**

Nottingham REC Centre  
The Old Chapel  
Royal Standard Place  
NG1 6FS

Telephone: 0115 8839309

02 April 2013

Mrs Marcela Alejandra Marin Dapelo  
PhD student  
Institute of Psychiatry, King's College London  
Institute of Psychiatry, Section of Eating Disorders  
103 Denmark Hill  
London  
SE5 8AZ

Dear Mrs Marin Dapelo

<b>Study title:</b>	<b>Emotion recognition and expression in individuals with Eating Disorders</b>
<b>REC reference:</b>	<b>13/LO/0201</b>
<b>Protocol number:</b>	<b>N/A</b>
<b>IRAS project ID:</b>	<b>121919</b>

Thank you for your letter of 20<sup>th</sup> March, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

We plan to publish your research summary wording for the above study on the NRES website, together with your contact details, unless you expressly withhold permission to do so. Publication will be no earlier than three months from the date of this favourable opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to withhold permission to publish, please contact the Assistant Co-ordinator Wendy Rees, NRESCommittee.London-WestLondon@nhs.net.

**Confirmation of ethical opinion**

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

**Ethical review of research sites**

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management

permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

### Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

*Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.*

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at <http://www.rdforum.nhs.uk>.

*Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.*

*For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.*

*Sponsors are not required to notify the Committee of approvals from host organisations*

**It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).**

### Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Interview Schedules/Topic Guides	1.0	21 December 2012
Investigator CV	Marcela Dapelo	21 December 2012
Other: CV	Dr Kate Tchanturia	21 December 2012
Other: CV	Robin Morris	21 December 2012
Other: Emotion recognition task	1.0	
Other: Point-light task		
Other: Film Clips task		
Other: Imitation task		
Other: Flow Chart	1.0	21 December 2012
Other: Poster for recruitment of all participants	1.0	21 December 2012
Other: Poster for recruitment of eating disorder participants		
Other: Poster for recruitment of recovered participants		
Other: Poster for recruitment of healthy control participants		
Participant Consent Form: Video/Audio Record	1.0	21 December 2012
Participant Consent Form	3	March 2013

Participant Information Sheet: Clinical Groups	2.0	March 2013
Participant Information Sheet: Healthy Controls	2.0	March 2013
Participant Information Sheet: Recovered Group	2.0	March 2013
Protocol	2	
Questionnaire: EDE-Q		
Questionnaire: WSAS		
Questionnaire: CIA		
Questionnaire: HADS		
Questionnaire: OCI-R		
Questionnaire: TAS-20		
Questionnaire: RSAS		
Questionnaire: SEQ		
Questionnaire: BEQ		
Questionnaire: BES		
Questionnaire: ATE		
Questionnaire: ERQ		
Questionnaire: AQ		
Questionnaire: PANAS		
Questionnaire: Demographic Information	2	
REC application	121919/405309/1/261	21 January 2013
Response to Request for Further Information		

### Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

### After ethical review

#### Reporting requirements

The attached document “*After ethical review – guidance for researchers*” gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

#### Feedback

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

Further information is available at National Research Ethics Service website > After Review

**13/LO/0201**

**Please quote this number on all correspondence**

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at <http://www.hra.nhs.uk/hra-training/>

With the Committee's best wishes for the success of this project.

Yours sincerely



**Dr Catherine Urch**  
**Chair**

Email: NRESCommittee.London-WestLondon@nhs.net

*Enclosures:* "After ethical review – guidance for  
researchers" [\[SL-AR2\]](#)

*Copy to:* Ms Jennifer Liebscher, Institute of Psychiatry / South London and Maudsley NHS  
Foundation Trust  
Kate Tchanturia



## **APPENDICES**

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### **APPENDIX B. PARTICIPANT INFORMATION SHEETS**

## INFORMATION SHEET FOR PARTICIPANTS

**Title of study:** Emotion recognition and expression in individuals with Eating Disorder.

Please read the following information before you decide whether to participate in this research

We would like to invite you to participate in this postgraduate research project. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Your participation in this study is completely voluntary. Thank you for reading this information sheet.

### What is the purpose of the study?

- The purpose of this study is to look at emotional characteristics that are thought to play a role in the maintenance of eating disorders, making recovery difficult.
- Previous research suggests that individuals with eating disorders may differ from healthy volunteers on certain aspects of emotional style.
- New treatments for eating disorders should address emotional characteristics, but further study of emotional difficulties is needed. This study aims to improve our understanding of these emotional difficulties, to inform the development of future treatments.

### Who can take part?

We are recruiting women with eating disorders who wish to participate in the study. If you are a woman between the ages of 18 and 55 years, and you have an eating disorder (anorexia or bulimia nervosa), you may be a good candidate for this study.

### Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part you will be given this information sheet and asked to sign a consent form. If you decide to take part you are still free to withdraw from participating and have your data withdrawn at any time without giving a reason.

### What will participation involve?

If you decide you would like to participate in this study, you will undergo the following procedures:

- First, we will conduct a short interview, in which we will ask you questions about your eating disorder, as well as other psychiatric problems. The purpose of this interview is to evaluate whether you are eligible to participate in the study. This interview will take 10-15 minutes.
- Then, you will be given a package of self-report questionnaires involving questions about demographic information (e.g. age, occupation, etc.), psychiatric symptoms, and emotion regulation. We estimate that it takes 20-30 minutes to complete all the questionnaires, but you will have a few days to complete this package, before the testing session.
- Finally, we will conduct a testing session, in which we will measure your height and weight, and you will complete 4 emotional computer tasks involving watching pictures and film clips, as well as questionnaires examining how you feel. These tasks will be recorded. This session will last 60-90 minutes, and will be carried out in the hospital ward, or at the Institute of Psychiatry.

**What are the benefits of taking part in this study?**

We hope to find out more about emotional characteristics associated with eating disorders. These results will improve our understanding and may contribute to the development of new treatments. Even though you will receive no direct benefit from taking part in this study, you may find the questionnaires and tasks interesting. We will also pay you £10 to thank you for your participation.

**What are the possible disadvantages or risks of taking part?**

There are no major risks associated with taking part in this study. The study will take up some of your time. If you find any of the questions upsetting, please talk to your care team. If during your participation in the study, we become concerned that you might be at risk of harming yourself or others, we will inform the health professional responsible for your care.

**Will I be paid for participating?**

Yes, you will receive £10 for participating in the study.

**Will it be possible to identify me from my results?**

Your participation in the study will be confidential. From the beginning of your involvement, you will be given an identification number and this will be used to match your completed measures rather than your name. Your data, including recorded information from the testing session, will be kept on password-protected computers and in locked storage. Your name will not appear anywhere in any publication or in any description of the findings. Only the researcher and supervisors will be allowed to see your files.

**Who is organising / funding the research?**

The research is being organised by the Eating Disorder Research Unit at the Institute of Psychiatry. The researcher (MMD) is being supported by a PhD studentship granted by the Chilean government.

**Who has approved this research?**

This study has been reviewed and given a favourable opinion by the West London NRES Ethics Committee.

**What should I do if there is a problem?**

If you have any concerns about any aspect of the research, please do not hesitate to contact us and we will do our best to answer your questions. If you feel your concern has not been fully addressed or wish to speak to an independent person you can contact the South London and Maudsley NHS Foundation Trust Patient Advice and Liaison Service (PALS) on 0203 228 2444 / 2499 or alternatively contact the King's College London Research Ethics Office using the following contact details, who will re-direct your complaint as appropriate: Research Ethics Office, King's College London, Room 7.21 James Clerk Maxwell Building, 57 Waterloo Road, London, SE1 8WA. Email: [rec@kcl.ac.uk](mailto:rec@kcl.ac.uk)

**What should I do if I want more information?**

For more information on any aspect of the study please contact one of the researchers using the contact details below.

**Marcela Marin Dapelo**

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**Supervisor: Dr. Kate Tchanturia**

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- New treatments for eating disorders should address emotional characteristics, but further study of emotional difficulties is needed. This study aims to improve our understanding of these emotional difficulties, to inform the development of future treatments.

### Who can take part?

We are recruiting women that never had a diagnosis of eating disorders, so we can compare their emotional characteristics with those who suffer an eating disorder. If you are a woman between the ages of 18 and 55 years, and you never had an eating disorder (anorexia or bulimia nervosa), you may be a good candidate for this study.

### Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part you will be given this information sheet and asked to sign a consent form. If you decide to take part you are still free to withdraw from participating and have your data withdrawn at any time without giving a reason.

### What will participation involve?

If you decide you would like to participate in this study, you will undergo the following procedures:

- First, we will conduct a short interview, in which we will ask you questions about some psychiatric problems. The purpose of this interview is to evaluate whether you are eligible to participate in the study. This interview will take 10-15 minutes.
- Then, you will be given a package of self-report questionnaires involving questions about demographic information (e.g. age, occupation, etc.), psychiatric symptoms, and emotion regulation. We estimate that it takes 20-30 minutes to complete all the questionnaires, but you will have a few days to complete this package, before the testing session.
- Finally, we will conduct a testing session, in which we will measure your height and weight, and you will complete 4 emotional computer tasks involving watching pictures and film clips, as well as questionnaires examining how you feel. These tasks will be recorded. This session will last 60-90 minutes, and will be carried out in the hospital ward, or at the Institute of Psychiatry.

**What are the benefits of taking part in this study?**

We hope to find out more about emotional characteristics associated with eating disorders. These results will improve our understanding and may contribute to the development of new treatments. Even though you will receive no direct benefit from taking part in this study, you may find the questionnaires and tasks interesting. We will also pay you £10 to thank you for your participation.

**What are the possible disadvantages or risks of taking part?**

There are no major risks associated with taking part in this study. The study will take up some of your time. If you find some of the questions upsetting, please consult the list of organisations designed to offer assistance with weight, eating and emotional problems. If during your participation in the study, we become concerned that you might be at risk of harming yourself or others, we will inform your GP.

**Will I be paid for participating?**

Yes, you will receive £10 for participating in the study.

**Will it be possible to identify me from my results?**

Your participation in the study will be confidential. From the beginning of your involvement, you will be given an identification number and this will be used to match your completed measures rather than your name. Your data, including recorded information from the testing session, will be kept on password-protected computers and in locked storage. Your name will not appear anywhere in any publication or in any description of the findings. Only the researcher and supervisors will be allowed to see your files.

**Who is organising / funding the research?**

The research is being organised by the Eating Disorder Research Unit at the Institute of Psychiatry. The researcher (MMD) is being supported by a PhD studentship granted by the Chilean government.

**Who has approved this research?**

This study has been reviewed and given a favourable opinion by the West London NRES Ethics Committee.

**What should I do if there is a problem?**

If you have any concerns about any aspect of the research, please do not hesitate to contact us and we will do our best to answer your questions. If you feel your concern has not been fully addressed or wish to speak to an independent person you can contact the South London and Maudsley NHS Foundation Trust Patient Advice and Liaison Service (PALS) on 0203 228 2444 / 2499 or alternatively contact the King's College London Research Ethics Office using the following contact details, who will re-direct your complaint as appropriate: Research Ethics Office, King's College London, Room 7.21 James Clerk Maxwell Building, 57 Waterloo Road, London, SE1 8WA. Email: [rec@kcl.ac.uk](mailto:rec@kcl.ac.uk)

**What should I do if I want more information?**

For more information on any aspect of the study please contact one of the researchers using the contact details below.

**Marcela Marin Dapelo**

[marcela.marin\\_dapelo@kcl.ac.uk](mailto:marcela.marin_dapelo@kcl.ac.uk)

**Supervisor: Dr. Kate Tchanturia**

[kate.tchanturia@kcl.ac.uk](mailto:kate.tchanturia@kcl.ac.uk)

Institute of Psychiatry  
Section of Eating Disorders  
103 Denmark Hill  
London SE5 8AF  
0207 8480160

If this study raises any difficult feelings for you and you would like to contact someone for support the following organisations should be able to help:

Beat Website: [www.b-eat.co.uk](http://www.b-eat.co.uk)  
Helpline: 0845 634 1414 (Monday to Friday, 10.30 am to 8.30pm and Saturdays 1.00pm – 4.30pm).  
Email: [help@b-eat.co.uk](mailto:help@b-eat.co.uk)

Samaritans Website: [www.samaritans.org](http://www.samaritans.org)  
Helpline: 08457 909090 (Open 24 hrs)  
Email: [jo@samaritans.org](mailto:jo@samaritans.org)  
Write to: Chris, PO Box 90 90, Stirling, FK8 2SA.

Mind Website: [www.mind.org.uk](http://www.mind.org.uk)  
Infoline: 0300 123 3393 (Monday to Friday 9.00am to 6.00pm)  
Email: [info@mind.org.uk](mailto:info@mind.org.uk)  
Write to: Mind infoline, PO Box 277, Manchester, M60 3XN.

## **APPENDICES**

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### **APPENDIX C. CONSENT FORMS**

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**CONSENT FORM**

---

Title of Project: Emotion recognition and expression in individuals with Eating Disorder

Name of Researcher: Marcela A. Marin Dapelo

Please initial all boxes

1. I confirm that I have read and understand the information sheet dated Mar 2013 (version 2.0) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected. ☐
3. I understand that relevant sections of data collected during the study, may be looked at by individuals from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐
4. I agree to my GP being informed of my participation in the study. ☐
5. I agree to take part in the above study. ☐
6. If you would like to be contacted in the future about participation in similar studies to this one please tick this box. By ticking this box you are agreeing for us to store your contact details. ☐

\_\_\_\_\_  
Name of Participant

\_\_\_\_\_  
Date

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Name of Person  
taking consent.

\_\_\_\_\_  
Date

\_\_\_\_\_  
Signature

Consent form date of issue: March 2013  
Consent form version number: 3.0

Page 1 of 1



**CONSENT TO VIDEO/AUDIO RECORD**

Emotion recognition and expression in individuals with Eating Disorder

**Please read the following carefully**

1. We would like to video and audio record whilst you participate in this study.
2. The recordings will not be made available to anyone outside of the direct research team.
3. The recordings will be stored password-protected computers at the Institute of Psychiatry.
4. No personal identifiable information will be kept with the recordings. The recordings will be labelled anonymously with participant numbers only.
5. The recordings will be destroyed once the research has finished.

***Consent***

I .....agree to the video/audio recording of my participation in this research. I understand that it will be used for research purposes only and not available to anyone outside the direct research team. I understand that it will be stored confidentially and anonymously and destroyed once the research has finished.

**SIGNED**

**DATE**

.....

.....

I confirm that the project has been explained to the participant:

**SIGNED (Researcher)**

**DATE**

.....

.....

## **APPENDICES**

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### **APPENDIX D. STRUCTURED CLINICAL INTERVIEW FOR DSM-IV (MODULE H) SCHEDULE**

ID:

Date:

SCID-I (for DSM-IV-TR)

Anorexia Nervosa

(JAN 2007)

Eating Disorders H. 1

**H. EATING DISORDERS****\*ANOREXIA NERVOSA\*****ANOREXIA NERVOSA CRITERIA**

<b>SCREEN Q#11</b>	
YES	NO

H1a

IF SCREENER NOT USED: Now I would like to ask you some questions about your eating habits and your weight. Have you ever had a time when you weighed much less than other people thought you ought to weigh?

IF YES: Why was that? How much did you weigh? How old were you then? How tall were you?

Age:  
Height:  
Weight:  
BMI:

A. Refusal to maintain body weight at or above a minimally normal weight for age and height (e.g., weight loss leading to maintenance of body weight less than 85% of that expected; or failure to make expected weight gain during period of growth, leading to body weight less than 85% of that expected).

?	1	2	3
---	---	---	---

GO TO *BULIMIA NERVOSA* H. 4
---------------------------------------

H1

At that time, were you very afraid that you could become fat?

B. Intense fear of gaining weight or becoming fat, even though underweight.

?	1	2	3
---	---	---	---

GO TO *BULIMIA NERVOSA* H. 4
---------------------------------------

H2

At your lowest weight, did you still feel too fat or that part of your body was too fat?

C. Disturbance in the way in which one's body weight or shape is experienced; undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight.

?	1	2	3
---	---	---	---

GO TO *BULIMIA NERVOSA* H. 4
---------------------------------------

H3

IF NO: Did you need to be very thin in order to feel good about yourself?

IF NO AND LOW WEIGHT IS MEDICALLY SERIOUS: When you were that thin, did anybody tell you it could be dangerous to your health to be that thin? (What did you think?)

ID:

Date:

SCID-I (for DSM-IV-TR)

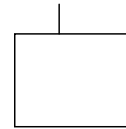
Anorexia Nervosa

(JAN 2007)

Eating Disorders H. 2

FOR FEMALES: Before this time, were you having your periods? Did they stop? (For how long?)

D. In postmenarchal females, amenorrhea, i.e., the absence of at least three consecutive menstrual cycles. (A woman is still considered to have amenorrhea if her periods occur only following hormone, e.g., estrogen, administration.)



H4

ANOREXIA NERVOSA CRITERIA A, B, AND C ARE CODED "3"

1

3

H5

GO TO  
\*BULIMIA  
NERVOSA\*  
H.4

ANOREXIA  
NERVOSA

(Do you have eating binges in which you eat a lot of food in a short period of time and feel that your eating is out of control? (How often?)

**SUBTYPE CURRENT EPISODE:**

During the current episode of Anorexia Nervosa (past 3 months), the person has regularly engaged in binge-eating or purging behavior (i.e., self-induced vomiting or misuse of laxatives, diuretics, or enemas).

1

3

H5a

RESTRICT-  
ING TYPE

BINGE-  
EATING/  
PURG-  
ING  
TYPE

IF NO: What kinds of things have you done to keep weight off? (Ever make yourself vomit or take laxatives, enemas, or water pills?) (How often?)

IF CURRENT AN-R:

Have you ever binge/purge?

IF YES

When was that (AGE)?

How often?

IF PAST HISTORY OF AN:

Subtype for last episode of AN:

ID:

Date:

SCID-I (for DSM-IV-TR)

Anorexia Nervosa

(JAN 2007)

Eating Disorders H. 3

**\*ANOREXIA NERVOSA CHRONOLOGY\***

IF UNCLEAR: During the past month, have you had (SXS OF ANOREXIA NERVOSA)?

Has met symptomatic criteria for Anorexia Nervosa during past month (criteria A, B, and C).

? 1 3

H6

**INDICATE CURRENT SEVERITY:**

- 1 - **Mild:** Few, if any, symptoms in excess of those required to make the diagnosis are present, and symptoms result in no more than minor impairments in social, or occupational functioning.
- 2 - **Moderate:** Symptoms or functional impairment between "mild" and "severe" are present.
- 3 - **Severe:** Many symptoms in excess of those required to make the diagnosis, or several symptoms that are particularly severe, are present, or the symptoms result in marked impairment in social or occupational functioning.

CONTINUE WITH **\*AGE AT ONSET\***, BELOW.

H7

**IF CURRENT CRITERIA NOT FULLY MET (OR NOT AT ALL):**

- 4 - **In Partial Remission:** The full criteria for the disorder were previously met, but currently only some of the symptoms or signs of the disorder remain.
- 5 - **In Full Remission:** There are no longer any symptoms or signs of the disorder, but it is still clinically relevant to note the disorder--for example, in an individual with previous episodes of Anorexia Nervosa who has been symptom free while receiving weekly psychotherapy for past year.
- 6 - **Prior History:** There is a history of the criteria having been met for the disorder, but the individual is considered to have recovered from it.

H8

When did you last have (ANY SXS OF ANOREXIA NERVOSA)?

Number of months prior to interview when last had a symptom of Anorexia Nervosa

\_\_\_\_\_

H9

**\*AGE AT ONSET\***

IF UNKNOWN: How old were you when you first started having (SXS OF ANOREXIA NERVOSA)?

Age at onset of Anorexia Nervosa (CODE 99 IF UNKNOWN).

\_\_\_\_\_

H10

GO TO **\*BULIMIA NERVOSA\*** H. 4

ID:

Date:

SCID-I (for DSM-IV-TR)

Anorexia Nervosa

(JAN 2007)

Eating Disorders H. 4

**\*BULIMIA NERVOSA\***

**BULIMIA NERVOSA CRITERIA**

IF: CRITERIA CURRENTLY MET FOR ANOREXIA NERVOSA, ASK FOR HISTORY OF BULIMIA NERVOSA

SCREEN Q#12	
YES	NO

H10a

IF NO:  
FINISHED

IF SCREENER NOT USED: Have you often had times when your eating was out of control? Tell me about those times.

IF UNCLEAR: During these times, do you often eat within any 2 hour period what most people would regard as an unusual amount of food? Tell me about that.

Could you describe an episode? (how much did you eat?)

A. Recurrent episodes of binge eating. An episode of binge eating is characterized by BOTH of the following:

(2) a sense of lack of control over eating during the episode (e.g., a feeling that one cannot stop eating or control what or how much one is eating)

? 1 2 3

H11

FINISHED
----------

(1) eating, in a discrete period of time (e.g., within any two hour period), an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances

? 1 2 3

H12

FINISHED
----------

Did you do anything to counteract the effects of eating that much? (Like making yourself vomit, taking laxatives, enemas or water pills, strict dieting or fasting, or exercising a lot?)

B. Recurrent inappropriate compensatory behavior in order to prevent weight gain, such as: self-induced vomiting; misuse of laxatives, diuretics, enemas, or other medications; fasting; or excessive exercise.

? 1 2 3

H13

GO TO *BINGE EATING DISORDER,* H. 7
---

How often were you eating that much (AND COMPENSATORY BEHAVIOR)? (At least once a week for at least 3 months?)

C. The binge eating and inappropriate compensatory behaviors both occur, on average, at least once a week for 3 months.

? 1 2 3

H14

GO TO *BINGE EATING DISORDER,* H. 7
---

Were your body shape and weight among the most important things that affected how you felt about yourself?

D. Self-evaluation is unduly influenced by body shape and weight.

?   1   2   3

H15

FINISHED

E. The disturbance does not occur exclusively during episodes of Anorexia Nervosa.

?   1   2   3

H16

FINISHED

BULIMIA NERVOSA CRITERIA A, B, C, D AND E ARE CODED "3."

1

3

H17

GO TO  
NEXT  
MODULE

BULIMIA  
NERVOSA

**SPECIFY TYPE:**

During the current episode of Bulimia Nervosa, the person has regularly engaged in self-induced vomiting or the misuse of laxatives, diuretics, or enemas.

1

3

H17a

NON-  
PURGING  
TYPE

PURGING  
TYPE

**\*BULIMIA NERVOSA CHRONOLOGY\***

IF UNCLEAR: During the past month, have you had (SXS OF BULIMIA NERVOSA)?

Has met symptomatic criteria for Bulimia Nervosa during past month (criteria A, B, C, D, and E). ? 1 3

H18

**INDICATE CURRENT SEVERITY:**

- 1 - **Mild:** Few, if any, symptoms in excess of those required to make the diagnosis are present, and symptoms result in no more than minor impairments in social, or occupational functioning.
- 2 - **Moderate:** Symptoms or functional impairment between "mild" and "severe" are present.
- 3 - **Severe:** Many symptoms in excess of those required to make the diagnosis, or several symptoms that are particularly severe, are present, or the symptoms result in marked impairment in social or occupational functioning.

H19

CONTINUE WITH **\*AGE AT ONSET,\*** BELOW.

**IF CURRENT CRITERIA NOT FULLY MET (OR NOT AT ALL):**

- 4 - **In Partial Remission:** The full criteria for the disorder were previously met, but currently only some of the symptoms or signs of the disorder remain.
- 5 - **In Full Remission:** There are no longer any symptoms or signs of the disorder, but it is still clinically relevant to note the disorder--for example, in an individual with previous episodes of Bulimia Nervosa who has been symptom free while receiving weekly psychotherapy for past year.
- 6 - **Prior History:** There is a history of the criteria having been met for the disorder, but the individual is considered to have recovered from it.

H20

When did you last have (ANY SXS OF BULIMIA NERVOSA)?

Number of months prior to interview when last had a symptom of Bulimia Nervosa

\_\_\_\_ \_

H21

**\*AGE AT ONSET\***

IF UNKNOWN: How old were you when you first started having (SXS OF BULIMIA NERVOSA)?

Age at onset of Bulimia Nervosa (CODE 99 IF UNKNOWN)

\_\_\_\_ \_

H22

FINISHED



**\*BINGE-EATING DISORDER\*****BINGE-EATING DISORDER CRITERIA  
(APPENDIX CATEGORY)**

During these binges...

B. The binge-eating episodes are associated with three (or more) of the following:

...did you eat much more rapidly than normal?

(1) eating much more rapidly than normal

? 1 2 3

H23

...eat until you felt uncomfortably full?

(2) eating until feeling uncomfortably full

? 1 2 3

H24

...eat large amounts of food when you didn't feel physically hungry?

(3) eating large amounts of food when not feeling physically hungry

? 1 2 3

H25

...eat alone because you were embarrassed by how much you were eating?

(4) eating alone because of being embarrassed by how much one is eating

? 1 2 3

H26

...feel disgusted with yourself, depressed, or feel very guilty after overeating?

(5) feeling disgusted with oneself, depressed or very guilty after overeating

? 1 2 3

H27

AT LEAST 3 "B" SXS CODED "3."

1 3

H28

FINISHED

Was it very upsetting to you that you couldn't stop eating or control what or how much you were eating?

C. Marked distress regarding binge eating is present.

? 1 2 3

H29

FINISHED

IF UNKNOWN: How often did you binge? (For how long?) (At least 2 days a week for at least 6 months?)

D. The binge eating occurs, on average, at least 2 days a week for 6 months.

? 1 2 3

H30

FINISHED

E. The binge eating is not associated with the regular use of inappropriate compensatory behaviors (e.g., purging, fasting, excessive exercise) and does not occur exclusively during the course of Anorexia Nervosa or Bulimia Nervosa.

? 1 2 3

H31

FINISHED

BINGE EATING DISORDER CRITERIA  
A, B, C, D, AND E ARE CODED "3."

1 3

H32

FINISHED BINGE EATING DISORDER

?=inadequate information

1=absent or false

2=subthreshold

3=threshold or true

**\*BINGE EATING DISORDER CHRONOLOGY\***

IF UNCLEAR: During the past month, have you had (SXS OF BINGE EATING DISORDER)?

Has met symptomatic criteria for Binge Eating Disorder during past month (criteria A, B, C, D, and E).

? 1 2 3

H33

**INDICATE CURRENT SEVERITY:**

- 1 - **Mild:** Few, if any, symptoms in excess of those required to make the diagnosis are present, and symptoms result in no more than minor impairments in social, or occupational functioning.
- 2 - **Moderate:** Symptoms or functional impairment between "mild" and "severe" are present.
- 3 - **Severe:** Many symptoms in excess of those required to make the diagnosis, or several symptoms that are particularly severe, are present, or the symptoms result in marked impairment in social or occupational functioning.

CONTINUE WITH **\*AGE AT ONSET,\*** BELOW.

H34

**IF CURRENT CRITERIA NOT FULLY MET (OR NOT AT ALL):**

- 4 - **In Partial Remission:** The full criteria for the disorder were previously met, but currently only some of the symptoms or signs of the disorder remain.
- 5 - **In Full Remission:** There are no longer any symptoms or signs of the disorder, but it is still clinically relevant to note the disorder--for example, in an individual with previous episodes of Anorexia Nervosa who has been symptom free while receiving weekly psychotherapy for past year.
- 6 - **Prior History:** There is a history of the criteria having been met for the disorder, but the individual is considered to have recovered from it.

H35

When did you last have (ANY SXS OF BINGE EATING DISORDER)?

Number of months prior to interview when last had a symptom of Binge Eating Disorder

\_\_\_\_\_

H36

**\*AGE AT ONSET\***

IF UNKNOWN: How old were you when you first started having (SXS OF BINGE EATING DISORDER)?

Age at onset of Binge Eating Disorder (CODE 99 IF UNKNOWN)

\_\_\_\_\_

H37

?=inadequate information

1=absent or false

2=subthreshold

3=threshold or true

## **APPENDICES**

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### **APPENDIX E. SELF-REPORT MEASURES**

## DEMOGRAPHIC INFORMATION

**Date of birth:** \_\_/\_\_/\_\_ **Age:** \_\_

**Is English your first language?** Yes / No

**What is your ethnicity?** .....

**Are you currently taking any psychiatric medication?** Yes / No

If yes, please give details (name/dose).....

.....

**Have you ever been diagnosed with a visual impairment?** Yes / No

If yes, is this corrected with an aide? (e.g. glasses, contact lenses) Yes / No

**Have you ever been diagnosed with a neurological condition?** Yes / No

If yes, please give details.....

**Have you ever been diagnosed with an eating disorder (e.g. anorexia nervosa, bulimia nervosa, binge eating disorder)?** Yes / No

**If you have been diagnosed with an eating disorder, how old were you when you were first diagnosed?** .....

**If you have been diagnosed with an eating disorder, what (if any) treatments have you received for the eating disorder (please provide approximate dates)?**

.....

.....

.....

**What is your current height?** ..... **What is your current weight?**.....

**What is the lowest ever weight you have been (as an adult)?** ..... **Age:**.....

**What is the highest ever weight you have been (as an adult) (Do not consider pregnancy)?**..... **Age:** .....

**What is your current employment status?**

- |                                     |  |
|-------------------------------------|--|
| <input type="checkbox"/> Full time  | <input type="checkbox"/> Retired                     |
| <input type="checkbox"/> Part time  | <input type="checkbox"/> Sick leave                  |
| <input type="checkbox"/> Unemployed | <input type="checkbox"/> House wife / husband        |
| <input type="checkbox"/> Student    | <input type="checkbox"/> Other .....(please specify) |

**What is your current or most recent occupation?**

.....

**If you are unemployed, please indicate for how long you have been unemployed for and what your previous occupation was:**

Unemployed for:.....

Previous occupation: .....

**What is the highest level of education you completed?**

- |  |   |
|--|---|
| <input type="checkbox"/> No qualifications | <input type="checkbox"/> University Degree          |
| <input type="checkbox"/> O Level / GCSE    | <input type="checkbox"/> Postgraduate Degree        |
| <input type="checkbox"/> A Level / NVQ     | <input type="checkbox"/> Other.....(please specify) |
| <input type="checkbox"/> Diploma / BTEC    |   |

**How many years of education have you received?** .....

**Are you married/single/have a partner?** .....

**Has anyone in your family been diagnosed with a psychiatric condition? Yes / No**

If yes, please give details.....

What relation is this person to you? .....

ID:  
Date:     /     /

**EDE-Q (Fairburn & Beglin, 1994)**

The following questions are concerned with the past four weeks only (28 days). Please read each question carefully and tick the appropriate box.

**Please answer all the questions.**

On how many days out of the past 28 days...	No days	1-5 days	6-12 days	13-15 days	16-22 days	23-27 days	Every day
1. Have you been deliberately trying to limit the amount of food you eat to influence your shape or weight?	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>
2. Have you gone for long periods of time (8 hours or more) without eating anything in order to influence your shape or weight?	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>
3. Have you <u>tried</u> to avoid eating foods which you like in order to influence your shape or weight?	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>
4. Have you tried to follow definite rules regarding your eating in order to influence your shape or weight; for example, a calorie limit, a set amount of food, or rules about what or when you should eat?	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>
5. Have you wanted your stomach to be empty?	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>
6. Has thinking about food or its calorie content made it much more difficult to concentrate on things you're interested in; for example, read, watch TV or follow a conversation?	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>
7. Have you been afraid of losing control over eating?	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>
8. Have you had episodes of binge eating?	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>
9. Have you eaten in secret? (Do not count binges)	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>	6 <input type="checkbox"/>

ID:  
Date:     /     /

	On how many days out of the past 28 days...	No days	1-5 days	6-12 days	13-15 days	16-22 days	23-27 days	Every day
10.	Have you definitely wanted your stomach to be flat?	0 <input type="text"/>	1 <input type="text"/>	2 <input type="text"/>	3 <input type="text"/>	4 <input type="text"/>	5 <input type="text"/>	6 <input type="text"/>
11.	Has thinking about shape or weight made it more difficult to concentrate on things you are interested in; e.g., read, watch TV or follow a conversation?	0 <input type="text"/>	1 <input type="text"/>	2 <input type="text"/>	3 <input type="text"/>	4 <input type="text"/>	5 <input type="text"/>	6 <input type="text"/>
12.	Have you had a definite fear that you might gain weight or become fat?	0 <input type="text"/>	1 <input type="text"/>	2 <input type="text"/>	3 <input type="text"/>	4 <input type="text"/>	5 <input type="text"/>	6 <input type="text"/>
13.	Have you felt fat?	0 <input type="text"/>	1 <input type="text"/>	2 <input type="text"/>	3 <input type="text"/>	4 <input type="text"/>	5 <input type="text"/>	6 <input type="text"/>
14.	Have you had a strong desire to lose weight?	0 <input type="text"/>	1 <input type="text"/>	2 <input type="text"/>	3 <input type="text"/>	4 <input type="text"/>	5 <input type="text"/>	6 <input type="text"/>
		None of the times	A few of the times	Less than ½ the time	Half the time	More than ½ the time	Most of the time	Every time
<b>Over the past 4 weeks (28 days)</b>								
15.	On what proportion of times that you have eaten have you <u>felt guilty</u> because of the effect on your shape or weight? (Do not count binges)	0 <input type="text"/>	1 <input type="text"/>	2 <input type="text"/>	3 <input type="text"/>	4 <input type="text"/>	5 <input type="text"/>	6 <input type="text"/>
16.	Have there been any times when you have felt that you have eaten what other people would regard as an unusually large amount of food given the circumstances?	0 <input type="text"/> No		1 <input type="text"/> Yes				
17.	How many such episodes have you had over the past four weeks?	<input type="text"/>						
18.	During how many of these episodes of overeating did you have a sense of having lost control over your eating?	<input type="text"/>						
19.	Have you had other episodes of eating in which you have had a sense of having lost control and eaten too much, but have <u>not</u> eaten an unusually large amount of food given the circumstances?	0 <input type="text"/> No		1 <input type="text"/> Yes				

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20. How many such episodes have you had over the past four weeks?

21. Have you made yourself sick (vomit) as a means of controlling your shape or weight?

0  
  
 No

1  
  
 Yes

22. How many times have you done this over the past four weeks?

23. Have you taken laxatives as a means of controlling your shape or weight?

0  
  
 No

1  
  
 Yes

24. How many times have you done this over the past four weeks?

25. Have you taken diuretics (water tablets) as a means of controlling your shape or weight?

0  
  
 No

1  
  
 Yes

26. How many times have you done this over the past four weeks?

27. Have you exercised hard as a means of controlling your shape or weight?

0  
  
 No

1  
  
 Yes

28. How many times have you done this over the past four weeks?

	Over the past 4 weeks (28 days)							Not at all	Slightly	Moderately	Markedly
29.	Has your weight influenced how you think about (judge) yourself as a person?	0	1	2	3	4	5	6			
		<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>			
30.	Has your shape influenced how you think about (judge) yourself as a person?	0	1	2	3	4	5	6			
		<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>			
31.	How much would it upset you if you had to weigh yourself once a week for the next four weeks?	0	1	2	3	4	5	6			
		<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>			



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	Over the past 4 weeks (28 days)		Not at all		Slightly		Moderately		Markedly	
			0	1	2	3	4	5	6	
32.	How dissatisfied have you felt about your weight?		<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
33.	How dissatisfied have you felt about your shape?		<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
34.	How concerned have you been about other people seeing you eat?		<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
35.	How uncomfortable have you felt seeing your body; for example, in shop window reflections, while undressing or taking a bath or shower?		<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
36.	How uncomfortable have you felt about others seeing your body; for example, in communal changing rooms, when swimming or wearing tight clothes?		<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

ID:  
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### HADS (Zigmond & Snaith, 1983)

This questionnaire is designed to let us know how you feel. Read each item below and circle the reply which comes closest to how you have been feeling in the past week.

Don't take too long over your replies, your immediate reaction to each item will probably be more accurate than a long, thought out response.

- |   |  |
|---|--|
| <b>1. I feel tense or 'wound up'</b><br>3 Most of the time<br>2 A lot of the time<br>1 From time to time, occasionally<br>0 Not at all  | <b>8. I feel as if I am slowed down</b><br>3 Nearly all the time<br>2 Very often<br>1 Sometimes<br>0 Not at all  |
| <b>2. I still enjoy the things I used to enjoy</b><br>3 Definitely as much<br>2 Not quite so much<br>1 Only a little<br>0 Hardly at all   | <b>9. I get a sort of frightened feeling like butterflies in the stomach</b><br>3 Very often<br>2 Quite often<br>1 Occasionally<br>0 Not at all  |
| <b>3. I get a sort of frightened feeling as if something awful is about to happen</b><br>3 Very definitely and quite badly<br>2 Yes, but not too badly<br>1 A little, but it doesn't worry me<br>0 Not at all | <b>10. I have lost interest in my appearance</b><br>3 Definitely<br>2 I don't take as much care as I should<br>1 I may not take quite as much care<br>0 I take just as much care as ever |
| <b>4. I can laugh and see the funny side of things</b><br>3 As much as I always could<br>2 Not quite so much now<br>1 Definitely not so much now<br>0 Not at all  | <b>11. I feel restless as if I have to be on the move</b><br>3 Very much indeed<br>2 Quite a lot<br>1 Not very much<br>0 Not at all  |
| <b>5. Worrying thoughts go through my mind</b><br>3 A great deal of time<br>2 A lot of the time<br>1 Not too often<br>0 Very little   | <b>12. I look forward with my enjoyment to things</b><br>3 As much as I ever did<br>2 Rather less than I did<br>1 Definitely less than I used to<br>0 Hardly at all                      |
| <b>6. I feel cheerful</b><br>3 Most of the time<br>2 Sometimes<br>1 Not often<br>0 Never  | <b>13. I get a sudden feeling of panic</b><br>3 Very often indeed<br>2 Quite often<br>1 Not very often<br>0 Not at all   |
| <b>7. I can sit at ease and feel relaxed</b><br>3 Definitely<br>2 Usually<br>1 Not often<br>0 Not at all  | <b>14. I can enjoy a good book or radio or television programme</b><br>3 Often<br>2 Sometimes<br>1 Not often<br>0 Very seldom  |

ID: / /  
Date: / /

### AQ

Below there are a list of statements. Please read each statement very carefully and rate how strongly you agree or disagree by circling your answer.

**Do not miss any statement out.**

Examples

E1. I am willing to take risks.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
E2. I like playing board games.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
E3. I find learning to play musical instruments easy.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
E4. I am fascinated by other cultures.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree

1. I often notice small sounds when others do not.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
2. I usually concentrate more on the whole picture, rather than the small details.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
3. I find it easy to do more than one thing at once.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
4. If there is an interruption, I can switch back to do what I was doing very quickly.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
5. I find it easy to "read between the lines" when someone is talking to me.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
6. I know how to tell if someone is listening to me.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
7. When I'm reading a story, I find it difficult to work out the character's intentions.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
8. I like to collect information about categories or things (e.g. types of car, types of bird, types of train, types of plant, etc.)	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
9. I find it easy to work out what someone is thinking or feeling just by looking at their face.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree
10. I find it difficult to work out people's intentions.	Definitely agree	Slightly agree	Slightly disagree	Definitely disagree

ID:  
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**OCI-R (Foa et al., 2002)**

The following statements refer to experiences that many people have in their everyday lives.

Circle the number that best describes **HOW MUCH** that experience has **DISTRESSED** or **BOTHERED** you during the **PAST MONTH**.

The numbers refer to the following verbal labels:

<b>Not at all</b>	<b>A little</b>	<b>Moderately</b>	<b>A lot</b>	<b>Extremely</b>
0	1	2	3	4

- |   |   |   |   |   |   |
|---|---|---|---|---|---|
| 1. I have saved up so many things that they get in the way.   | 0 | 1 | 2 | 3 | 4 |
| 2. I check things more often than necessary.  | 0 | 1 | 2 | 3 | 4 |
| 3. I get upset if objects are not arranged properly.  | 0 | 1 | 2 | 3 | 4 |
| 4. I feel compelled to count while I am doing things.   | 0 | 1 | 2 | 3 | 4 |
| 5. I find it difficult to touch an object when I know it has been touched by strangers or certain people. | 0 | 1 | 2 | 3 | 4 |
| 6. I find it difficult to control my own thoughts.  | 0 | 1 | 2 | 3 | 4 |
| 7. I collect things I don't need.   | 0 | 1 | 2 | 3 | 4 |
| 8. I repeatedly check doors, windows, drawers, etc.   | 0 | 1 | 2 | 3 | 4 |
| 9. I get upset if others change the way I have arranged things.   | 0 | 1 | 2 | 3 | 4 |
| 10. I feel I have to repeat certain numbers.  | 0 | 1 | 2 | 3 | 4 |
| 11. I sometimes have to wash or clean myself simply because I feel contaminated.                          | 0 | 1 | 2 | 3 | 4 |
| 12. I am upset by unpleasant thoughts that come into my mind against my will.                             | 0 | 1 | 2 | 3 | 4 |
| 13. I avoid throwing things away because I am afraid I might need them later.                             | 0 | 1 | 2 | 3 | 4 |
| 14. I repeatedly check gas and water taps and light switches after turning them off.                      | 0 | 1 | 2 | 3 | 4 |
| 15. I need things to be arranged in a particular order.   | 0 | 1 | 2 | 3 | 4 |
| 16. I feel that there are good and bad numbers.   | 0 | 1 | 2 | 3 | 4 |
| 17. I wash my hands more often and longer than necessary.   | 0 | 1 | 2 | 3 | 4 |
| 18. I frequently get nasty thoughts and have difficulty in getting rid of them.                           | 0 | 1 | 2 | 3 | 4 |

ID: \_\_\_\_\_  
 Date:     /     /

**TAS-20 (Bagby et al., 2004)**

Circle the number that best describes to what extent you agree or disagree with each statement.

The numbers refer to the following verbal labels:

<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neither Disagree or Agree</b>	<b>Agree</b>	<b>Strongly Agree</b>
1	2	3	4	5

1. I am often confused about what emotion I am feeling. 1 2 3 4 5
2. It is difficult for me to find the right words for my feelings. 1 2 3 4 5
3. I have physical sensations that even doctors don't understand. 1 2 3 4 5
4. I am able to describe my feelings easily. 1 2 3 4 5
5. I prefer to analyze problems rather than just describe them. 1 2 3 4 5
6. When I am upset, I don't know if I am sad, frightened, or angry. 1 2 3 4 5
7. I am often puzzled by sensations in my body. 1 2 3 4 5
8. I prefer to just let things happen rather than to understand why they turned out that way. 1 2 3 4 5
9. I have feelings I can't quite identify. 1 2 3 4 5
10. Being in touch with emotions is essential. 1 2 3 4 5
11. I find it hard to describe how I feel about people. 1 2 3 4 5
12. People tell me to describe my feelings more. 1 2 3 4 5
13. I don't know what's going on inside me. 1 2 3 4 5
14. I often don't know why I am angry. 1 2 3 4 5
15. I prefer talking to people about their daily activities rather than their feelings. 1 2 3 4 5
16. I prefer to watch "light" entertainment shows rather than psychological dramas. 1 2 3 4 5
17. It is difficult for me to reveal my innermost feelings, even to close friends. 1 2 3 4 5
18. I can feel close to someone, even in moments of silence. 1 2 3 4 5
19. I find examination of my feelings useful in solving personal problems. 1 2 3 4 5
20. Looking for hidden meanings in movies or plays distracts from their enjoyment. 1 2 3 4 5

ID:  
Date:     /     /  
Film:

### PANAS (pre-film)

This scale consists of a number of words that describe different feelings and emotions.

Read each item and then circle the appropriate answer next to that word. Indicate to what extent you experienced each emotion **right now**.

	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
1. Interested	1	2	3	4	5
2. Distressed	1	2	3	4	5
3. Excited	1	2	3	4	5
4. Upset	1	2	3	4	5
5. Strong	1	2	3	4	5
6. Guilty	1	2	3	4	5
7. Scared	1	2	3	4	5
8. Hostile	1	2	3	4	5
9. Enthusiastic	1	2	3	4	5
10. Proud	1	2	3	4	5
11. Irritable	1	2	3	4	5
12. Alert	1	2	3	4	5
13. Ashamed	1	2	3	4	5
14. Inspired	1	2	3	4	5
15. Nervous	1	2	3	4	5
16. Determined	1	2	3	4	5
17. Attentive	1	2	3	4	5
18. Jittery	1	2	3	4	5
19. Active	1	2	3	4	5
20. Afraid	1	2	3	4	5

ID:  
Date:     /     /  
Film:

### PANAS (post-film)

This scale consists of a number of words that describe different feelings and emotions.

Read each item and then circle the appropriate answer next to that word. Indicate to what extent you experienced each emotion whilst watching the film.

	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
1. Interested	1	2	3	4	5
2. Distressed	1	2	3	4	5
3. Excited	1	2	3	4	5
4. Upset	1	2	3	4	5
5. Strong	1	2	3	4	5
6. Guilty	1	2	3	4	5
7. Scared	1	2	3	4	5
8. Hostile	1	2	3	4	5
9. Enthusiastic	1	2	3	4	5
10. Proud	1	2	3	4	5
11. Irritable	1	2	3	4	5
12. Alert	1	2	3	4	5
13. Ashamed	1	2	3	4	5
14. Inspired	1	2	3	4	5
15. Nervous	1	2	3	4	5
16. Determined	1	2	3	4	5
17. Attentive	1	2	3	4	5
18. Jittery	1	2	3	4	5
19. Active	1	2	3	4	5
20. Afraid	1	2	3	4	5

## **APPENDICES**

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### **APPENDIX F. TASK INSTRUCTIONS**



## **FEEST Instructions**

### Instructions for participants

“During this task, you will see a series of pictures of faces, along with 5 words describing emotions.

Each time you see a picture, please choose the word from the list of emotions that best describes the facial expression shown.

You can choose a word by clicking on the circle that appears before each word. You can only choose one word per picture.

After you have chosen a word (and clicked on it), please click on the NEXT button to go to the next picture.

Please do not click on the NEXT button until you have chosen a word for the picture. Do not spend too much time on each picture.”

## **PLW instructions**

### Instructions for participants

“I am going to show you a series of video clips. In each clip you will see a number of dots moving from the left side of the screen to the right side of the screen.

At the end of each film clip I would like you to choose a word from the list that best describes the emotional content of the clip you have just seen.

(Show list of words and read them aloud).

Do not spend too much time on each film clip and if you are not sure which emotion best suits the clip than you should go with your ‘gut instinct’ or guess.

We will first do some practice trials.

(After first clip ask)

In that clip did you see a human figure moving on the screen?

(After practice trials say)

We will now start the task, after each clip has finished please tell me which word best describes the emotional content of the clip.”

## **Film clips instructions**

### Instructions for participants

“In this part of the assessment you are being asked to watch two film clips.

First, waves will play for about 30 seconds. Following this, an instruction will appear on the screen asking you to press the space bar to pause the video and fill in the ‘pre-film’ questionnaire.

After completing the questionnaire, press the spacebar, and then a film clip will start. This will run for about 2 minutes. Allow yourself to get into the story as much as possible.

When the film clip ends, an instruction will appear on the screen asking you to press the space bar to pause the video and fill in the ‘post-film’ questionnaire.

After completing the questionnaire, press the spacebar, which will start the assessment again.

In total this assessment should last approximately 10 minutes. Please try not to put your hands in front of your face.”

## **Posed/imitation task - instructions**

### Instructions for participants

“During this task, I am going to ask you to show the computer a facial expression for certain emotions, and to imitate certain facial expressions

We are recording this task through a camera in the computer (show the camera) when you think you have the facial expression, please look at the camera and hold your facial expression for 3 seconds. 1...2...3.

For example, in the first part I will ask you to pose a facial expression. Let's say I ask 'please show the computer a facial expression for surprise...' (do example)

Do you have any questions?

### **Task #1. Posed facial emotions**

In the first task, I am going to ask you to show the computer the facial expression of certain emotions

Please show the computer the facial expression for:

Rand#1: Sadness – Disgust – Anger – Fear – Happiness

Rand#2: Anger – Fear – Happiness – Sadness – Disgust

Rand#3: Disgust – Sadness – Anger – Fear – Happiness

Now, please look at the camera and hold your facial expression for 3 seconds...1... 2... 3

### **Task #2. Imitation**

In this task, I am going to ask you to imitate some facial expressions that you will see on the screen

When you see a facial expression on the screen, please say out loud the number, and then try to imitate it

When you think you have it, please look at the camera and hold your facial expression for 3 seconds...1....2....3

Then you can click on the Enter button or the Space bar to go to the next picture

Try to imitate it the best you can, but don't spend too much time on each picture”

## **APPENDICES**

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### **APPENDIX G. FACS CERTIFICATION**

# *Facial Action Coding System*

## *Final Test*

### *Congratulations Marcela A. Marin Dapelo*

*Your scores on the FACS Final Test show you have*



## ***PASSED***

*this test of skill in scoring facial actions.*

**From the authors of FACS**

Paul Ekman, Wallace V. Friesen, Joseph C. Hager